Status Assessment of Pitcher's Thistle and Hart's-tongue Fern: Acquiring Contemporary Information for Recovery Planning and Five-Year Reviews

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Cover photograph: Flowering Pitcher's thistle, *Cirsium pitcheri*, Davenport Creek, Mackinac County, Michigan. Photographed by B.S. Slaughter.

ABSTRACT

The objective of this project was to conduct methodical, prioritized status assessments for the federally threatened plants Pitcher's thistle (*Cirsium pitcheri* (Torr.) Torr. & A. Gray) and American hart's-tongue fern (*Asplenium scolopendrium* L. var. *americanum* (Fernald) Kartesz & Gandhi) to address information needs and data gaps critical for recovery planning and development of five-year reviews. At the initiation of this project in 2011, review of the Michigan natural heritage database (NHD), which represents the most comprehensive state-wide distribution and status information for *C. pitcheri*, demonstrated that many element occurrences (EOs) had not been assessed since the mid-1990s or earlier. This project was designed to address critical information gaps for *C. pitcheri* EOs, including updated data on population size(s), habitat condition, precise spatial extent, and threats, through the utilization of systematic field inventories.

A total of 77 *Cirsium pitcheri* EOs were surveyed during the 2012 – 2016 field seasons. All flowering and non-flowering plants were counted, for a total of 260,005 *C. pitcheri* individuals. GPS tracks and data points were captured to assess site-specific distribution patterns, which allowed us to improve and update spatial representation in the NHD. We also completed threat assessments for all 77 sites. These document and score disturbances and threats such as presence of invasive species, deer herbivory, off-road vehicle damage and foot traffic, and presence and scale of sand mining and other infrastructure developments. One emerging threat, the invasive weevil *Larinus planus*, was located at several *C. pitcheri* sites in Lower Michigan, at almost every spot-checked non-dune site supporting its target species, Canada thistle (*C. arvense*), and at several wetland sites feeding on the native swamp thistle (*C. muticum*). No invasive weevils were found at any of the Upper Michigan sites. Further surveys are needed to determine if *L. planus* colonizes these sites and sites on the Great Lakes islands. The threat assessments can aid in the prioritization and implementation of site-specific management to address critical threats to the long-term viability of individual *C. pitcheri* populations.

Nine of the 10 documented EOs for *Asplenium scolopendrium* var. *americanum* were surveyed and censused, resulting in the documentation of over 15,000 individual plants divided among three life stages. To our knowledge, this is the most comprehensive census of the Michigan EOs, and the resulting statewide population estimate is significantly greater than previously understood.

INTRODUCTION

Pitcher's thistle (*Cirsium pitcheri* (Torr.) Torr. & A. Gray) is a monocarpic thistle endemic to sandy shorelines in the Great Lakes region. *C. pitcheri* is federally threatened and state-listed as endangered or threatened throughout its range in the United States. In Canada, *C. pitcheri* is listed as a species of Special Concern (NatureServe 2015). *C. pitcheri* is a colonizer of open sand habitat in early- to mid-successional vegetation maintained by intermediate levels of disturbance (Bowles et al. 1993). Most extant populations occur in Michigan, which has 170 element occurrences (EOs) documented in the Michigan Natural Heritage Database (NHD) as of March 2017.

American Hart's-tongue Fern (*Asplenium scolopendrium* L. var. *americanum* (Fernald) Kartesz & Gandhi) is a rare saxicolous fern primarily occurring in association with the Niagara Escarpment in the Great Lakes region (Ontario, New York, and Michigan), with small outlying populations in Tennessee and Alabama (Penskar and Higman 1996; NatureServe 2015). *A. scolopendrium* var. *americanum* is federally threatened and state-listed as endangered in Michigan and Tennessee and threatened in New York. In Canada, *A. scolopendrium* var. *americanum* is listed as a species of Special Concern (NatureServe 2015).

Throughout its range, *A. scolopendrium* var. *americanum* occurs in association with dolomitic limestone (NatureServe 2015). Ten EOs are documented from Michigan as of March 2017.

This report reviews the Michigan distribution and conservation status of *Cirsium pitcheri* and *Asplenium scolopendrium* var. *americanum* in Michigan, and summarizes some of the current threats to the Michigan populations. The objectives of this project were to:

- Provide the USFWS with contemporary status information for the Federally Pitcher's thistle and American hart's-tongue fern by addressing critical data gaps and surveying and updating selected Michigan occurrences to facilitate recovery planning and five-year reviews
- Acquire relevant data on significant threats during population censuses and status surveys of Pitcher's thistle
- Visit Pitcher's thistle occurrences to detect the possible presence of two invasive, highly destructive, weevil species now known to occur in Michigan
- Provide information that can be used for a variety of recovery planning activities such as:
    - Determining when the species meets delisting criteria specified in recovery plans
    - Preparing Five-year Reviews and ascertaining population trend information
    - Reviewing permits and participating in Section 6 consultations
    - Evaluating and prioritizing future land acquisitions
    - Refining and/or developing species critical habitat designations
    - Providing information for Habitat Conservation Plans (HCPs) and safe harbor agreements

METHODS

Site Selection

The NHD was used as the basis for site selection. *Cirsium pitcheri* and *Asplenium scolopendrium* var. *americanu*m EO polygon layers were overlaid on recent aerial imagery, topographic map layers, and ownership layers (plat maps) to assist navigation in the field. In addition, previously compiled site-specific reports, data forms, notes, and other materials, where available, were included in the field packets. Sites were prioritized in consultation with staff from the USFWS East Lansing Ecological Services Field Office, with emphasis on visiting *C. pitcheri* sites that were last surveyed in the mid-1990s or earlier and all accessible *A. scolopendrium* var. *americanum* sites.

Field Surveys – Pitcher's Thistle

We conducted meander surveys throughout appropriate dune habitat at each site, collecting geospatial data for each flowering and non-flowering (rosettes, including seedlings) *Cirsium pitcheri* individual using hand-held GPS units such as the AshTech MobileMapper, paired with a customized data collection application developed for ArcPad software. Survey tracks were spaced to help ensure that all thistles were counted at each site. All GPS tracks were saved for future reference and to aid follow-up monitoring. Sites were surveyed as early as early to mid-June in southern Michigan (2012 – 2013) to as late as mid-August in northern Lower Michigan and eastern Upper Michigan (2013 – 2016). Surveys were primarily conducted when all life stages of *C. pitcheri* were evident and to coincide with peak flowering. In addition to the collection of geospatial and count data, vegetation at a subset of sites was characterized by completing a dune species checklist (Appendix 1) and potential threats to the habitat and *C. pitcheri* populations were recorded and scored for every site (Appendix 2).

Field Surveys – American Hart's-tongue Fern

Census counts for *Asplenium scolopendrium* var. *americanum* followed Brumbelow (2014). All sporophytes noted within and adjacent to previously mapped occupied habitat were marked using ArcPad software on handheld GPS units, counted, and placed into one of three size classes: (1) sporelings, representing individuals with fronds <2.5 cm in length bearing no sori; (2) immature, representing individuals with largest fronds >2.5 cm in length but bearing no sori; and (3) mature, representing individuals with at least one frond bearing sori. Surveys were conducted in August 2016, when all size classes were present.

Element Occurrence Updates

Following field surveys, EOs for surveyed *Cirsium pitcheri* and *Asplenium scolopendrium* var. *americanum* populations were updated with population data, threats (for *C. pitcheri*), and refined spatial representations. Where possible, spatial representations were redrawn based on the new field surveys. Older spatial representations were retained if a portion(s) of the area was not surveyed, or if suitable habitat indicates the possibility of extant plants despite negative surveys. All surveyed EOs were assigned a new element occurrence rank (or a previous element occurrence rank was reconfirmed) based in part on criteria developed for the most recent USFWS Five-year Review for *C. pitcheri* (USFWS 2010) and generic occurrence rank specifications applicable to both species (Hammerson et al. 2008). Individual EO maps depicting occupied habitat, GPS points, counts, and previous and updated EO ranks were developed to aid management, monitoring, and research and are attached (Appendices 3, 4).

RESULTS

Field Surveys – Pitcher's Thistle

Over the course of five field seasons (2012 – 2016), a total of 77 EOs were visited, representing 45% of the 170 EOs currently mapped and tracked by MNFI (some occurrences were lumped or split following 2012 – 2016 surveys, and several new occurrences were documented, resulting in no net change in # of EOs). These sites occurred in four areas: (1) southwestern and west-central Lower Michigan, from Berrien County north to Oceana County; (2) far northern and northeastern Lower Michigan, from Charlevoix County (including the Beaver Island archipelago) to Alcona County; (3) the Thumb (Huron County); and (4) the eastern Upper Peninsula, from eastern Delta County east to the Chippewa County mainland, and one site on Lake Superior in Alger County (Figure A).

A total of 260,005 *Cirsium pitcheri* individuals were counted, including 43,451 (16.7%) flowering plants and 216,643 rosettes and seedlings (83.3%). Site counts ranged from 0 – 139,496 plants, with 73 of the 77 sites (95%) supporting fewer than 10,000 plants (Figure B). The 10 largest occurrences surveyed were in eastern Upper Michigan (eight EOs) and extreme northern Lower Michigan (two EOs), with generally smaller populations in southern Lower Michigan (Figure B). The percentage of flowering/fertile individuals varied considerably among sites, but was on average lowest in eastern Upper Michigan (ca. 21%), indicating a relatively high percentage of immature individuals including seedlings (Figure C). We were unable to relocate previously documented populations at eight of the 77 sites (10%).

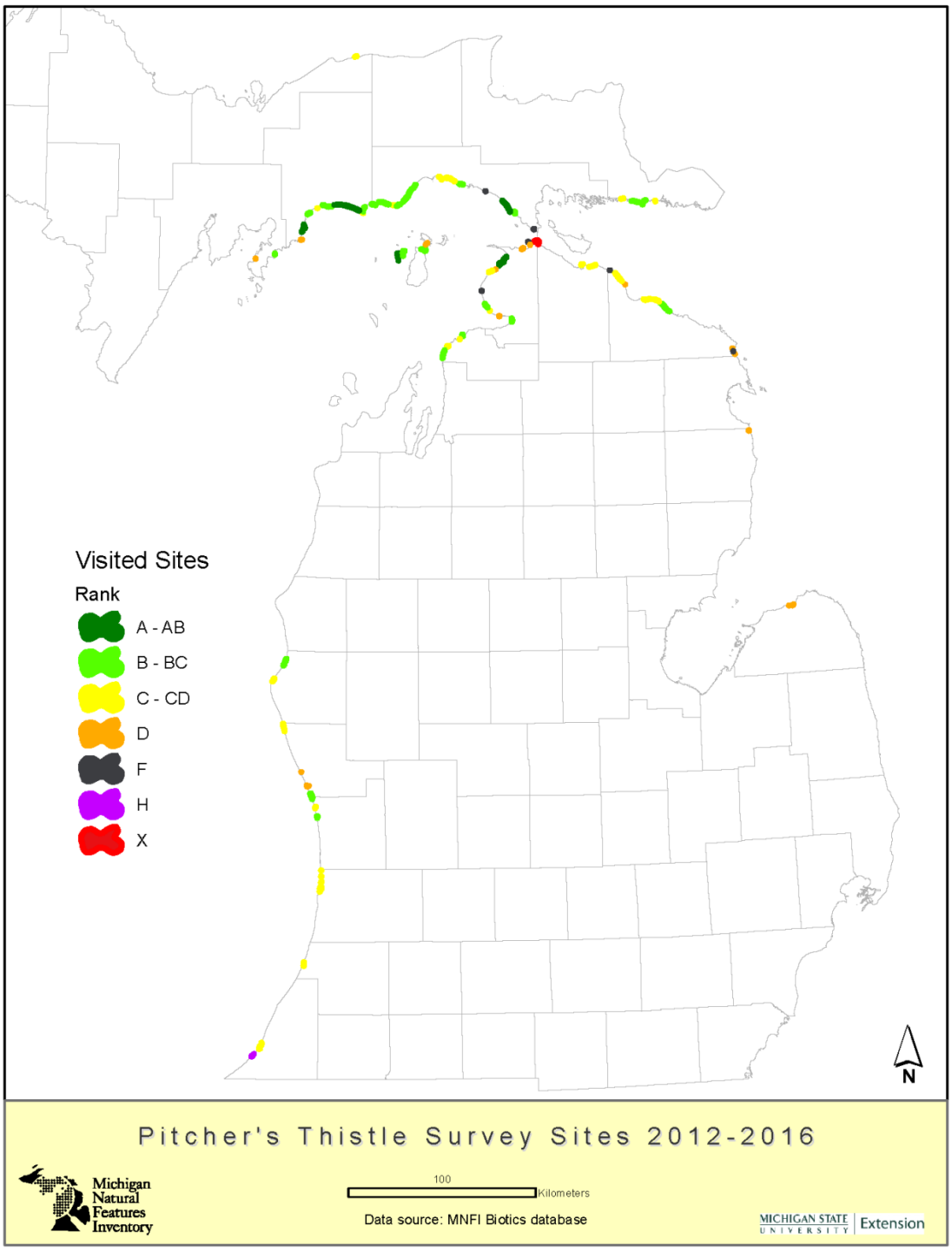

Figure A. Distribution and element occurrence (EO) ranks for 77 *Cirsium pitcheri* populations surveyed between 2012 and 2016.

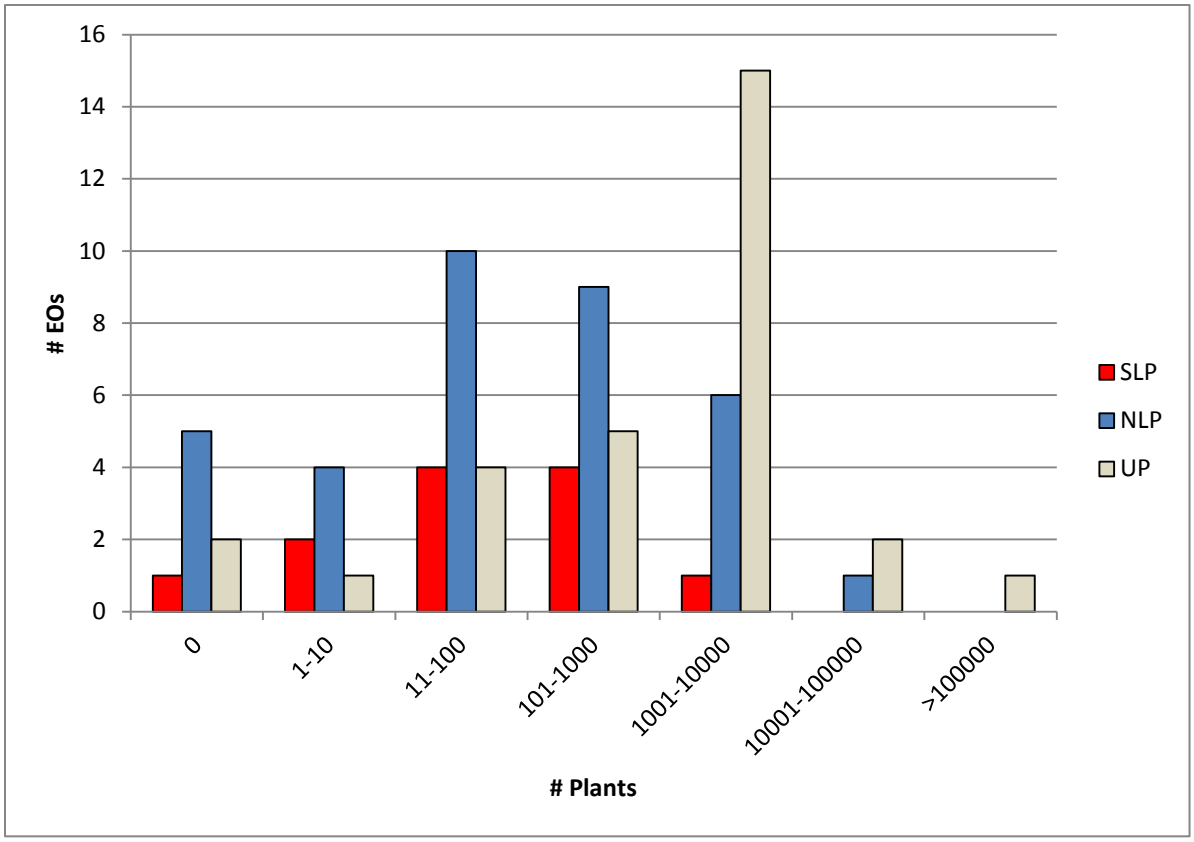

Figure B. Counts by Region for 77 *Cirsium pitcheri* EOs surveyed 2012 – 2016. Regions correspond to Albert's(1995) Regional Landscape Ecosystems (SLP: Section VI; NLP: Section VII; UP: Section VIII).

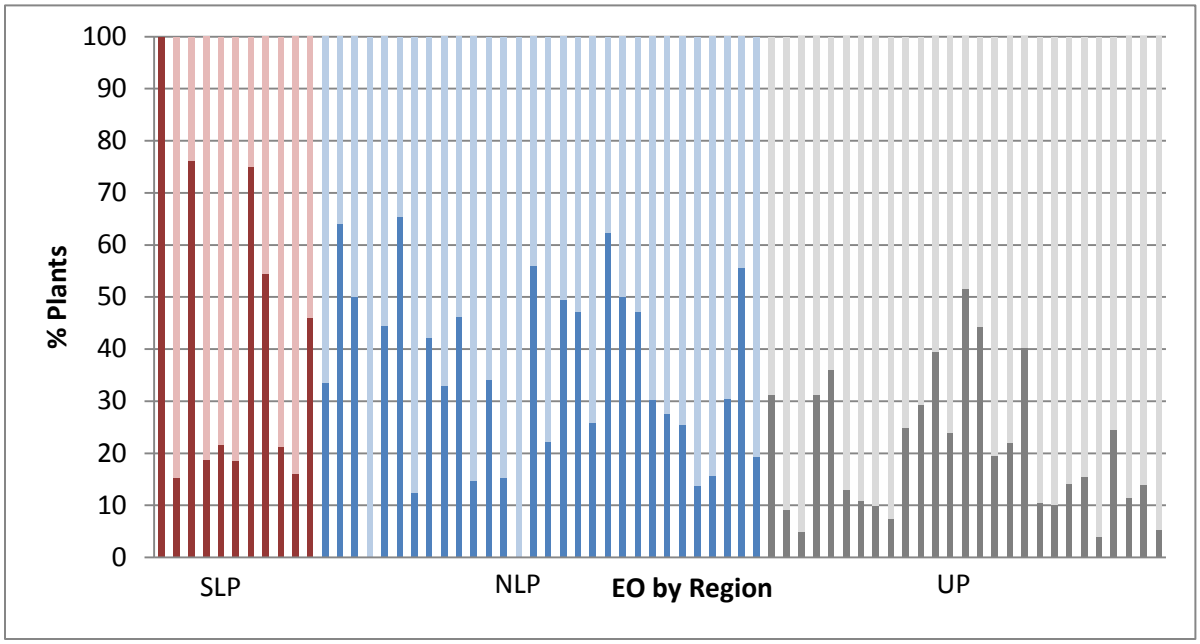

Figure C. % Flowering (dark bars) and rosettes (light bars) for 68 extant EOs. Regions correspond to Albert's (1995) Regional Landscape Ecosystems (SLP: Section VI; NLP: Section VII; UP: Section VIII).

EO ranks were adjusted for 52 of the previously documented 72 EOs (72%) following the 2012 – 2016 field surveys, with the five new EOs receiving new ranks (Figure D). EO ranks were downgraded for 33 sites, remained the same at 20 sites, and upgraded at 19 sites. Updated EO ranks were generally correlated with previous ranks (Figure E), with an average adjustment per EO of approximately one-half rank (e.g., A to AB). EO ranks were adjusted for a variety of reasons, including apparent expansions or contractions of populations, delineation of previously unmapped or unsurveyed habitat, the nature, scale, scope, and reversibility of threats, and a more consistent application of EO rank standards, based largely on the criteria outlined in Hammerson et al. (2008) and USFWS (2010). Among the 77 EOs surveyed, only five were ranked or re-ranked A or AB (excellent viability or excellent to good viability) following field surveys (Figure D).

The primary threats noted were invasive plants (especially spotted knapweed, *Centaurea stoebe*) and recreational use of the dunes, both vehicular and foot traffic. These threats were nearly ubiquitous. The non-native weevil *Larinus planus*, a species introduced to the central United States to control weedy rangeland thistles that has since spread to several native *Cirsium* spp., was detected at several sites in Lower Michigan. This species reduces *C. pitcheri* fecundity and has the potential to cause at least localized extirpation of the species in its natural habitats (Havens et al. 2012).

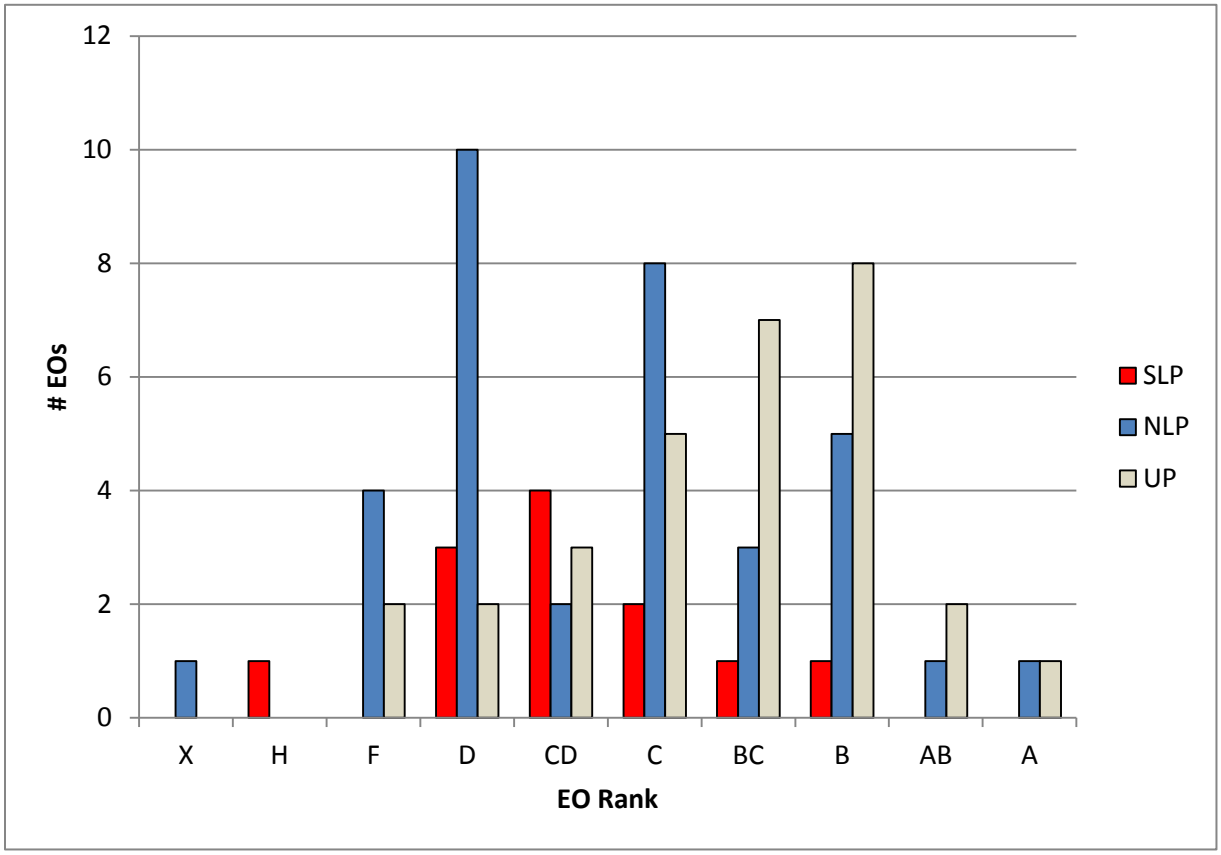

Figure D. Updated and New Element Occurrence Ranks by Region for 77 *Cirsium pitcheri* EOs surveyed 2012 – 2016. Regions correspond to Albert's (1995) Regional Landscape Ecosystems (SLP: Section VI; NLP: Section VII; UP: Section VIII).

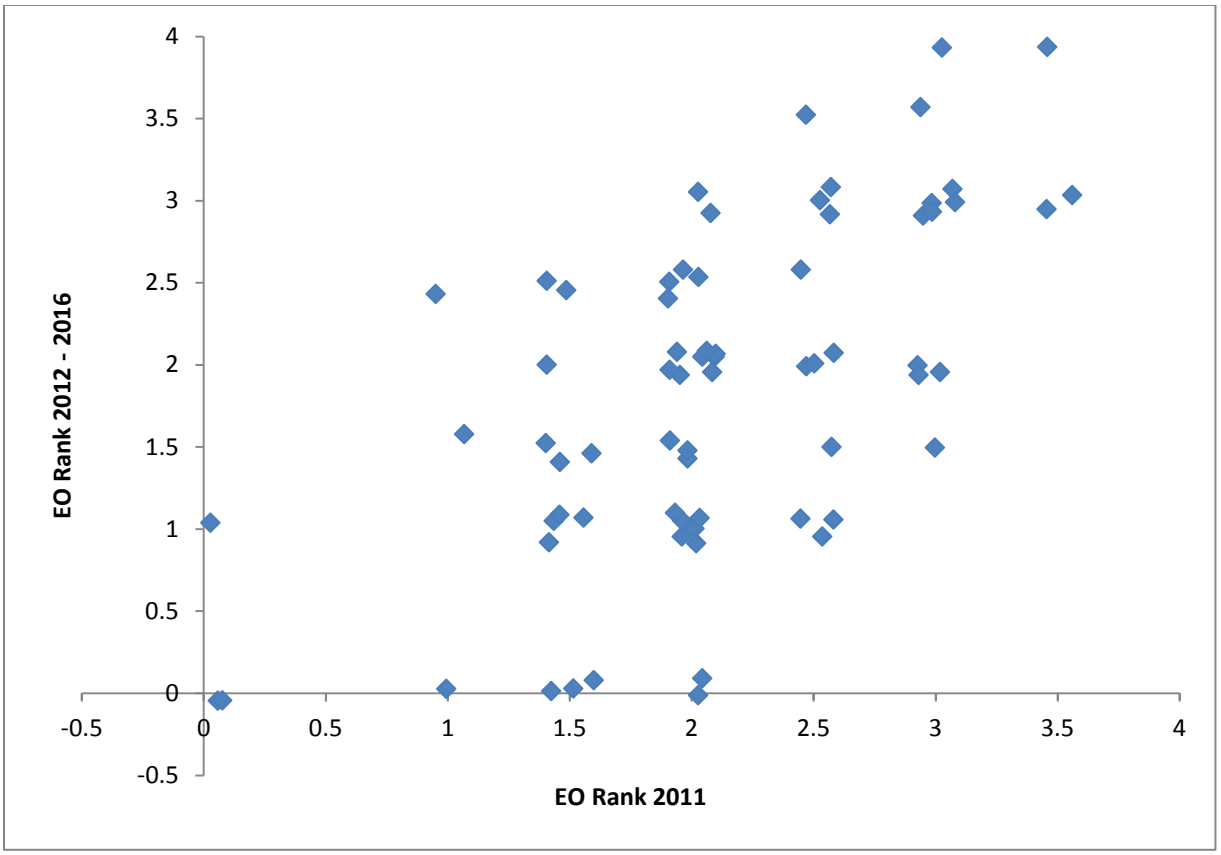

Figure E. Updated EO ranks are generally correlated with previous ranks. Identical data points are jittered to eliminate visual overlap. EO Rank numerical conversions: X, H, and F = 0; D = 1; CD = 1.5; C = 2; BC = 2.5; B = 3; AB = 3.5; A = 4.

Field Surveys – American Hart's-tongue Fern

Nine of the 10 documented EOs, all in eastern Upper Michigan, were visited in 2016 (Figure F). A total of 15,407 individual *Asplenium scolopendrium* var. *americanum* were counted, including 5,745 fertile plants, 7,511 infertile plants, and 2,151 sporelings (or stunted infertile plants <2.5 cm) (Table 1). Colony counts ranged from 0 – 8,351 plants, with two of the nine extant sites supporting nearly 90% of the total number of plants. We were unable to relocate one colony in 2016, following a similar negative survey in 2014. That colony was historically reduced by poaching and may now be extirpated. The unsurveyed colony is on private land for which access was not granted. EO Ranks were retained for seven colonies and slightly downgraded for one colony (Table 1).

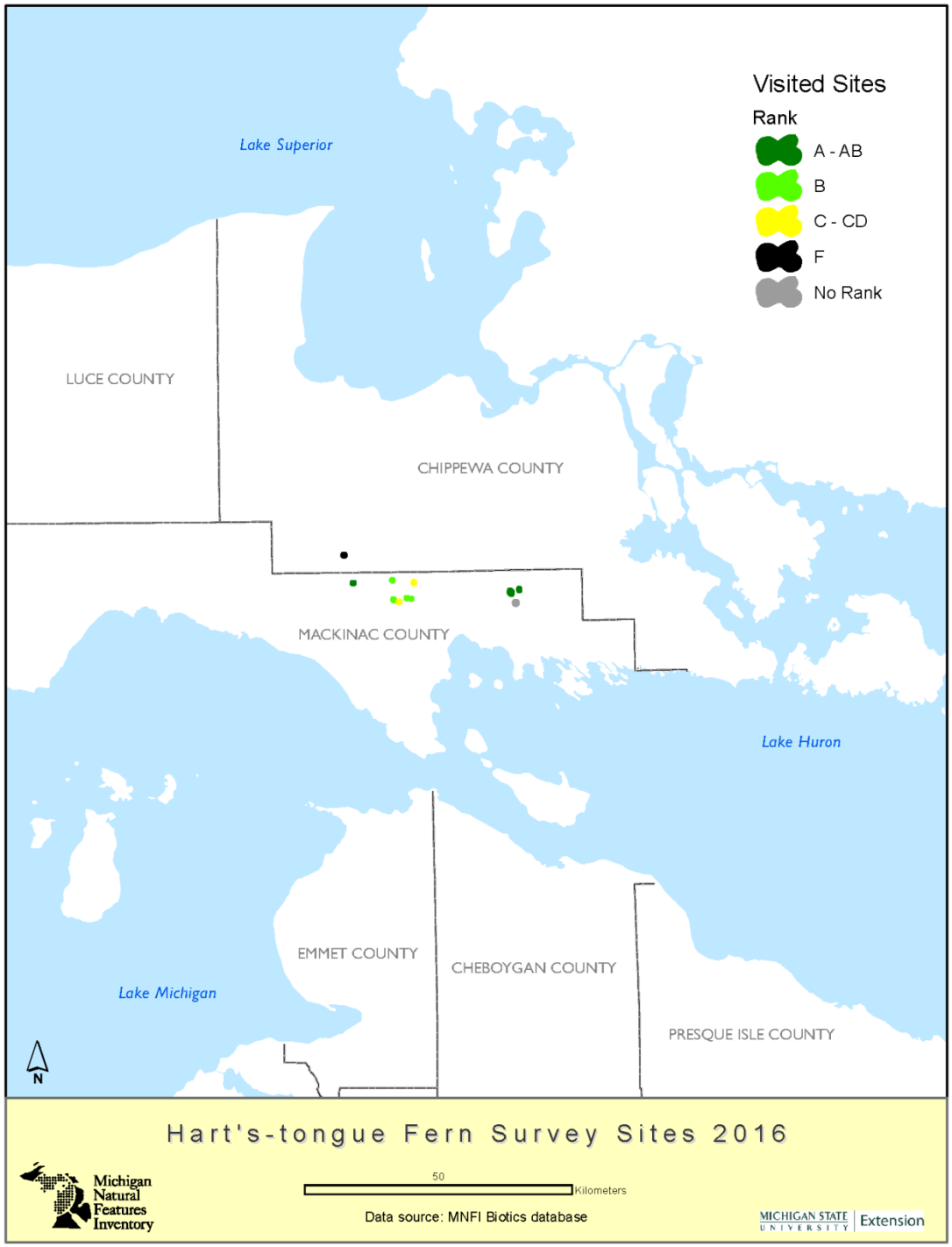

Figure F. Distribution and element occurrence (EO) ranks for nine *Asplenium scolopendrium* var. *americanum* populations surveyed in 2016.

Table 1. 2016 Census Data for *Asplenium scolopendrium* var. *americanum* Populations in Eastern Upper Michigan.

Site	EO #	EOID	Survey Date	Sporelings	Immature	Mature	Mature + Immature	Total	Old Rank	New Rank
Hill Lake SW	3	9605	08/18/2016	1451	4162	2738	6900	8351	A	A
Hill Lake E	5	8956	08/17/2016	289	2664	2182	4846	5135	A	A
Taylor Creek	7	2987	08/04/2016	321	377	190	567	888	AB	AB
East Lake Road	9	2695	08/04/2016	66	146	391	537	603	B	B
East Lake NE	1	8467	08/04/2016	6	46	27	73	79	C	C
Great Lakes Pipeline*	10	2696	08/04/2016	0	13	33	46	46	C	CD
Trout Lake	2	5767	08/06/2016	0	0	0	0	0	D	F
East Lake SW	4	1320	08/03/2016	6	60	110	170	176	B	B
Carp River North Branch	8	6448	08/05/2016	12	43	74	117	129	B	B
Hill Lake SE	6	8661	-	-	-	-	-	-	A	-
			TOTALS	**2151**	**7511**	**5745**	**13256**	**15407**		

DISCUSSION

Pitcher's Thistle

The *Cirsium pitcheri* surveys conducted from 2012 – 2016 represent the most complete set of consistently collected data for the Michigan populations, yet over half of the previously documented EOs were not revisited, reflecting both survey priorities and the significant costs associated with conducting complete censuses. Notably, some of the state's largest concentrations of populations at sites such as Nordhouse Dunes Wilderness Area, Sleeping Bear Dunes National Lakeshore, most of the Beaver Island archipelago, and Grand Sable Dunes were not surveyed. At Grand Sable Dunes, Danielson (2012) employed two sampling methods that resulted in population estimates of 152,000 to greater than 300,000 individuals, which potentially exceeds the total combined number of 260,005 individuals counted from the 77 EOs surveyed by MNFI. Based on our data, Danielson (2012), and previously collected population data and estimates in the MNFI NHD, the total Michigan population of *C. pitcheri* flowering plants, rosettes, and seedlings may (possibly significantly) exceed 1,000,000 individuals. This estimate is an order of magnitude greater than the figure reported by NatureServe (2015).

Although several *Cirsium pitcheri* EOs consist of very large populations or subpopulations, 23 of the EOs (30%) were either not relocated, were found to be extirpated, or supported low numbers of individuals (Figures B, D). Several EOs in southern Lower Michigan, in particular, appear to be on the verge of extirpation. Loss of these populations would further fragment the distribution of the species along the southern margins of the Lake Michigan basin and isolate the remaining colonies (Jolls et al. 2015). Conservation of *C. pitcheri* in these areas may ultimately require assisted introduction due to the relative unimportance of long-distance seed dispersal and the short lives of seeds in existing seedbanks (Jolls et al. 2015) and consequent inbreeding depression (Gauthier et al. 2010). EO viability generally increased from south to north, with the largest and hypothetically most secure populations and population clusters occurring along the northern shore of Lake Michigan in eastern Upper Michigan and on islands in northern Lower Michigan. EO ranks following the 2012 – 2016 surveys were generally correlated with ranks assigned after earlier surveys (Figure E), but overall population trends and trends for individual EOs are not evident due to the qualitative, often incomplete or inconsistently collected original EO data and the lack of long-term datasets at most sites.

The Threats Assessments emphasized the ubiquitous nature of two threats, invasive plants and recreational use (primarily beach use and foot traffic in dunes). *Centaurea stoebe* (spotted knapweed) was the primary non-native plant noted by surveyors, and occurred at most sites, often in at least local abundance. However, interpretation of the severity and reversibility of infestations varied by investigator, likely in part reflecting the difficulty in attempting to infer impacts from observations alone (Girdler et al. 2016). Recent research indicates that spotted knapweed reduces juvenile survival and reduces and delays flowering of *C. pitcheri* individuals occurring in close proximity (Rand et al. 2015), so the reduction and eradication of spotted knapweed populations in *C. pitcheri*-occupied habitat is recommended. The interpretation of severity and reversibility of recreational use also varied, likely in part due to the potential for specific disturbances to have both positive (e.g., creation of suitable microhabitats for seed germination) and negative (e.g., trampling, excessive soil erosion) impacts on *C. pitcheri* individuals and differing opinions on the difficulty and cost associated with reducing or eliminating incompatible recreational uses. The utility of the Threats Assessments should be improved through the development of a scoring system more specific to target species and habitats.

In 2010, the non-native weevil *Larinus planus* was noted infesting a native population of *Cirsium pitcheri* in Wisconsin, and subsequent investigations revealed a more widespread infestation, reducing fecundity of affected populations by approximately 50% (Havens et al. 2012). During the course of our study, *L. planus* was detected at several *C. pitcheri* sites in Lower Michigan, every randomly spot-checked population of its target *C. arvense* (Canada thistle), and at several wetland sites where it infested the native *C. muticum* (swamp thistle). *L. planus* was not detected at the Beaver Island archipelago sites or in Upper Michigan during the course of our study (2012 – 2016). Repeated census counts at affected sites are recommended to determine if the weevil is impacting *C. pitcheri* populations at Michigan sites, and annual monitoring is recommended to detect the likely arrival of *L. planus* to sites that lacked weevils at the time of our surveys.

The emerging nature of two of the most important threats to *Cirsium pitcheri*, namely, non-native weevils and climate change (not addressed by our study, but see Staehlin and Fant 2015), likely limit the relevance of our population counts to a relatively short period of time. Repeated follow-up censuses of at least a subsample of our sites are recommended to help facilitate continued recovery planning.

American Hart's-tongue Fern

The total Michigan population (excluding one unsurveyed EO) for *Asplenium scolopendrium* var. *americanum* is considerably higher than estimates reported by Wiley (2014) and NatureServe (2015). Even excluding sporelings, which have not been consistently reported in other counts in the United States (Brumbelow 2014), over 13,000 individuals were counted, vs. approximately 5,240 individuals excluding sporelings counted/estimated by J. Wiley and others in 2014 (Wiley 2014). The disparity between these numbers is primarily the result of complete counts in 2016 at two EOs owned by Michigan Nature Association, which accounted for 11,746 individuals excluding seedlings (13,486 including seedlings) (Table 1). The new total Michigan population estimate is notable because existing literature suggests the majority of the United States population occurs in New York, with some figures suggesting as much as 92% of U.S. plants occur in that state (Cinquemani Kuehn and Leopold 1992, and cited in more recent papers). Instead, the Michigan count is considerably higher than the figure of ca. 3,000 – 4,000 mature and immature sporophytes excluding sporelings cited for New York for several counts from 2008 – 2012 (Brumbelow 2014). These figures suggest Michigan, not New York, supports the majority (perhaps exceeding 75%) of the United States population of *A. scolopendrium* var.

americanum, although direct comparisons would require consistently collected data from both states over multiple years. To reduce potential impacts to populations, Brumbelow (2014) suggests a rotating annual census of a subset of EOs to monitor population dynamics over time, and we concur for Upper Michigan populations. In addition, the one EO that was not surveyed, a privately owned site near the two largest colonies, should be censused in the near future. We also suggest implementation of environmental monitoring at *A. scolopendrium* var. *americanum* sites to track changes in vegetation (including death of canopy trees and invasion and spread of non-native plants) and microclimate (e.g., temperature, relative humidity, precipitation, snow cover) that may be associated with the colony viability.

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Appendix 1. Open Dunes Vascular Plant Species Checklist.

Open Dunes Checklist Site name:_____ Surveyors:_____ Date:_____

D = dominant, co-dominant **A**= abundant **C**= common **U**= uncommon **R**=rare **I**= characteristic **LD**= locally dominant **LC**= locally common **E=** exotic

	Abies balsamea		GYPSOPHILA PANICULATA		Populus balsamifera		TRIFOLIUM SPP.		
	Acer rubrum		GYPSOPHILA SCORZONER.		Populus deltoides		Tsuga canadensis		
	Acer saccharum		Hamamelis virginiana		Populus grandidentaa		Vaccinium angustifolium		
	ACHILLEA MILLEFOLIUM		HIERACIUM AURANTIACUM		POPULUS NIGRA V. ITAL		Vaccninium myrtilloides		
	Agropyron dasystachyum		HIERACIUM CAESPITOSUM		Populus tremuloides		VERBASCUM THAPSUS		
	AGROPYRON REPENS		HIERACIUM SPP.		PRUNELLA VULGARIS		VIBURNIUM OPULUS		
	Agropyron trachycaulum		Hudsonia tomentosa		Prunus pumila		Vitis riparia		
	AGROSTIS GIGANTEA		Hypericum kalmianum		Prunus serotina		Zigadenus glaucus		
	Ammophila breviligulata		HYPERICUM PERFORATUM		Prunus virginiana		TRIFOLIUM SPP.		
	Andropogon scoparius		Juncus balticus		Ptelea trifoliata		Tsuga canadensis		
	Anemone multifida		Juniperus communis		Pteridium aquilinum		Vaccinium angustifolium		
	Arabis lyrata		Juniperus horizontalis		Orobanche fasciculata		Vaccninium myrtilloides		
	ARCTIUM MINUS		Juniperus virginiana		Quercus rubra		VERBASCUM THAPSUS		
	Arctostaphylos uva-ursi		Koeleria macrantha		Quercus spp.		VIBURNIUM OPULUS		
	Artemisia campestris		Larix laricina		RHAMNUS CATHARTICA		Vitis riparia		
	Asclepias syriaca		Lathyrus japonicus		RHAMNUS FRANGULA		Zigadenus glaucus		
	Asclepia viridiflora		LEONURUS CARDIACA		Rhus spp.		TRIFOLIUM SPP.		
	Asclepias spp.		LEYMUS ARENARIUS		ROBINIA PSEUDOACACIA		Tsuga canadensis		
	BARBAREA VULGARIS		LINARIA VULGARIS		Rosa acicularis		Vaccinium angustifolium		
	BERTEROA INCANA		Lithospermum caroliniense		Rosa blanda		Vaccninium myrtilloides		
	Betula papyrifera		LONICERA XBELLA		Rosa carolina		VERBASCUM THAPSUS		
	BROMUS INERMIS		LONICERA JAPONICA		ROSA MULTIFLORA		VIBURNIUM OPULUS		
	Cakile edentula		LONICERA MORROWII		Rubus alleghaniensis		Vitis riparia		
	Calamovilfa longifolia		LONICERA TATARICA		Rubus flagellaris		Zigadenus glaucus		
	Campanula aparinoides		MEDICAGO LUPULINA		Rubus hispidus		TRIFOLIUM SPP.		
	CELASTRUS ORBICULATUS		Melampyrum lineare		Rumex acetosella		Tsuga canadensis		
	Celastrus scandens		MELILOTUS ALBA		RUMEX CRISPUS		Vaccinium angustifolium		
	CENTAUREA STOEBE		MELILOTUS OFFICINALIS		Salix cordata		Vaccninium myrtilloides		
	CHRYSANTHEMUM LEUC.		Monarda fistulosa		Salix exigua		VERBASCUM THAPSUS		
	CICHORIUM INTYBUS		Monarda punctata		Salix myricoides		VIBURNIUM OPULUS		
	CIRSIUM ARVENSE		MORUS ALBA		SALIX PURPUREA		Vitis riparia		
	Cirsiium palustre		Oenothera biennis		Salix serissima		Zigadenus glaucus		
	CIRSIUM VULGARE		Panicum virgatum		Salix spp.				
	Coreopsis lanceolata		Panicum spp.		SAPONARIA OFFICINALIS				
	CORONILLA VARIA		PASTINACA SATIVA		Sassafras albidum				
	Cornus stolonifera		PHALARIS ARUNDINACEA		Schoenoplectus pungens				
	CYCLOLOMA ATRIPLICI.		PHLEUM PRATENSE		SEDUM ACRE				
	Cyperus schweinitzii		Phragmites australis		Shepherdia canadensis				
	DAUCUS CAROTA		PHRAGMITES AUSTRALIS		SILENE VULGARIS				
	Deschampsia flexuosa		Physocarpus opulifolius		Smilacina stellata				
	Dicanthelium commonsianum		Picea glauca		Solidago altissima				
	ELAEAGNUS UMBELLATA		Pinus banksiana		Solidago simplex (spathulata)				
	Elymus canadensis		PINUS NIGRA		Solidago spp.				
	EPIPACTUS HELLEBORINE		Pinus resinosa		SONCHUS SPP.				
	Equisetum hyemale		Pinus strobus		Sphenopholis intermedia				
	ERUCASTRUM GALLICUM		PINUS SYLVESTRIS		TANACETUM VULGARE				
	Euphorbia corollata		PLANTAGO SPP.		Tanacetum huronense				
	Euphorbia polygonifolia		POA COMPRESSA		TARAXACUM OFFICINALE				
	EUPHORBIA SPP.		POA SPP.		Thuja occidentalis				
	Euthamia graminifolia		Polygonella articulata		Tilia americana				
	Fagus grandifolia		Polygonum cuspidatum		TORILIS JAPONICA				
	FESTUCA ARUNDINACEA		POLYGONUM SPP.		Toxicodendron radicans				
	Festuca saximontana		Potentilla anserina		Toxicodendron rydbergii				
	Festuca spp.		Potentilla fruticosa		TRAGOPOGON DUBIOUS				
	Fragaria virginiana		POPULUS ALBA		TRIFOLIUM PRATENSE				

Appendix 2. Threats Assessment Field Form.

Threats Assessment – GLRI Surveys

Surveyor(s):_____ Date:_____

Survey site:_____

Threat	Severity	Scope	Reversibility	Threat Score	Comments
Invasive Species					
Deer Herbivory					
ORV Activity					
Foot Traffic/ Rec. Activity					
Hydrologic Alteration					
Infrastructure/ Trail Development					
Water Quality/ Contamination					

Rank each observed threat in terms of Severity, Scope, and Reversibility on a scale of 1 to 5.
Severity is the level of damage to the site and a score of 1 means the site is slightly damaged and a score of 5 means the site has been extensively damaged.
Scope is the geographic extent of impact and a score of 1 means the threat occupies a trace area within the site and a score of 5 means the threat is ubiquitous.
Reversibility is the probability of controlling the threat and reversing the damage and a score of 1 means the threat can be easily controlled and a score of 5 means the threat is unlikely to be controlled.
Threat Score is a sum of the rankings for Severity, Scope, and Reversibility.

Severity:

5: Without action, the community will likely be destroyed or eliminated (beyond restoration) within 10-15 years
4: Without action, the community will likely be seriously degraded (potentially lowered by 1 EO Rank) within 10-15 years
3: Without action, the community will likely be moderately degraded (potentially lowered by 1/2 EO Rank) within 10-15 years
2: Without action, the community will likely be slightly impaired by this threat within 10-15 years
1: Without action, the community may be slightly impaired by this threat within 15+ years
0: No threat

Scope:

5: Threat impacts the entire community EO (90%+)
4: Threat impacts large portions of the community EO (roughly 50-89%)
3: Threat impacts moderate portions of the community EO (roughly 15-49%)
2: Threat impacts localized portions of the community EO (roughly 5-14%, possibly in several scattered small patches)
1: Threat impacts only one small patch within or on the edge of the community EO, or is currently outside EO in the vicinity but likely to impact EO within the next 10 years
0: No threat

Reversibility:

5: Threat is not reversible (e.g., parking lot/paving)
4: Threat is reversible but not practically affordable without major investment of $ and time (potentially hundreds of thousands of dollars or full time staff effort)
3: Threat is reversible but moderately difficult and requires a fair investment of $ and/or time (potentially tens of thousands of dollars or 2+ weeks of staff time/year)
2: Threat is reversible at relatively low cost (potentially several days of staff time/year or up to a few thousand dollars)
1: Threat is easily reversible with only a few hours of effort (potentially annually) by a small group of people such as volunteers or state workers
0: No threat

Appendix 3. Maps and Data for Updated *Cirsium pitcheri* EOs.

Site Name: Thompson Dunes

EO #: 1
EO ID: 2642
EO Rank 2011-PRE: C
EO Rank new: BC

Number of mature plants: 178
Number of immature plants: 1469
Occupied acreage: 40.1
Survey date: 2016-06-29

Field GPS points
Occupied acreage
500
Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Naubinway East

EO #:	3	**Number of mature plants:**	110
EO ID:	7840	**Number of immature plants:**	138
EO Rank 2011-PRE:	C	**Occupied acreage:**	6.2
EO Rank new:	C	*Survey date:*	*2014-07-17*

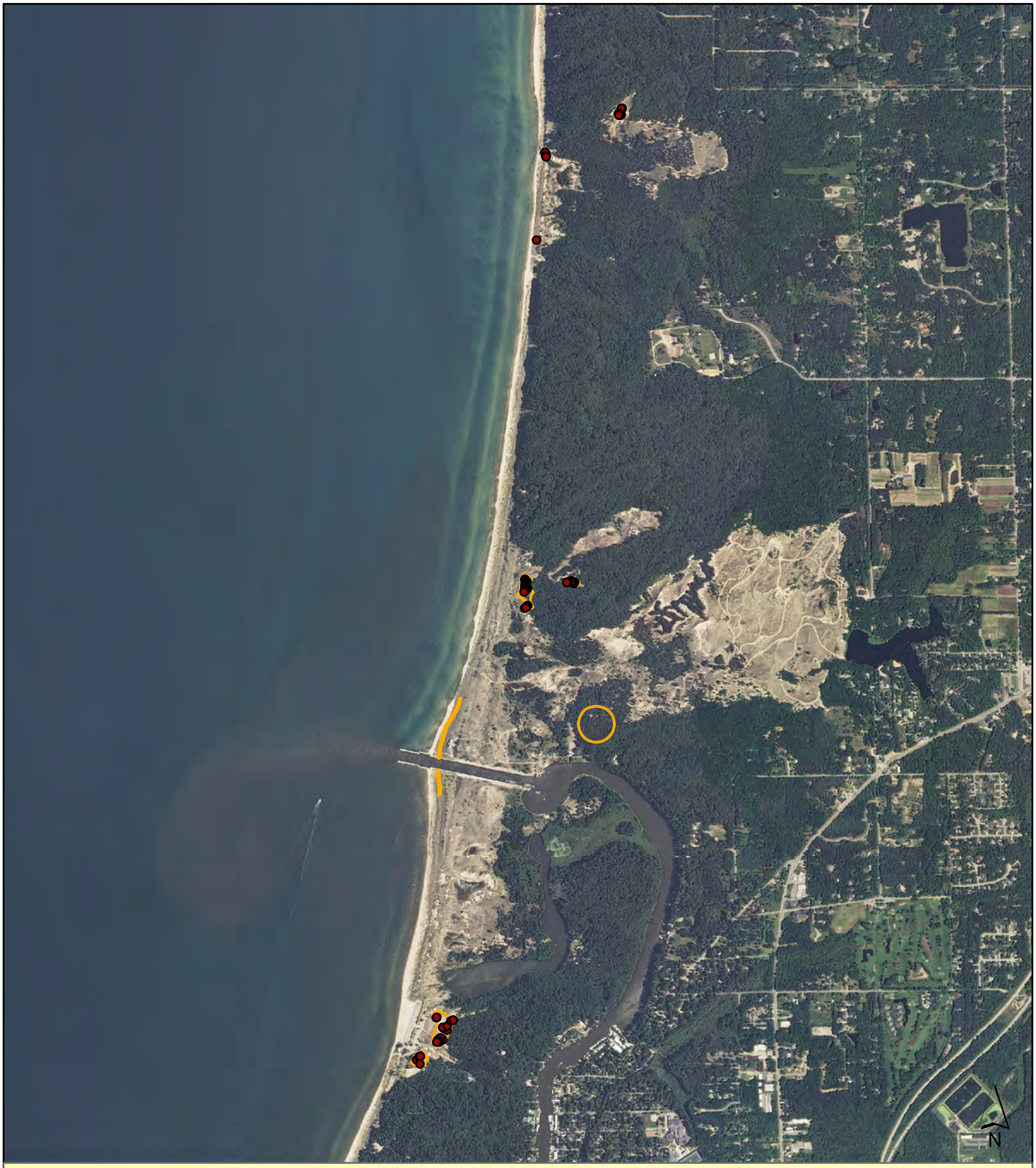
Field GPS points

Occupied acreage

570 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Saugatuck Dunes

EO #:	4	**Number of mature plants:**	32
EO ID:	4204	**Number of immature plants:**	177
EO Rank 2011-PRE:	C	**Occupied acreage:**	17.1
EO Rank new:	C	*Survey date:*	*2013-08-16*

Field GPS points

Occupied acreage

1,500 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Charlevoix City Beach

EO #: 6
EO ID: 12592
EO Rank 2011-PRE: D
EO Rank new: CD

Number of mature plants: 65
Number of immature plants: 405
Occupied acreage: 1.7
Survey date: 2013-06-19

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Kitchel Dunes

EO #:	8	**Number of mature plants:**	23
EO ID:	7371	**Number of immature plants:**	83
EO Rank 2011-PRE:	C	**Occupied acreage:**	3.6
EO Rank new:	C	*Survey date:*	*2012-06-20*

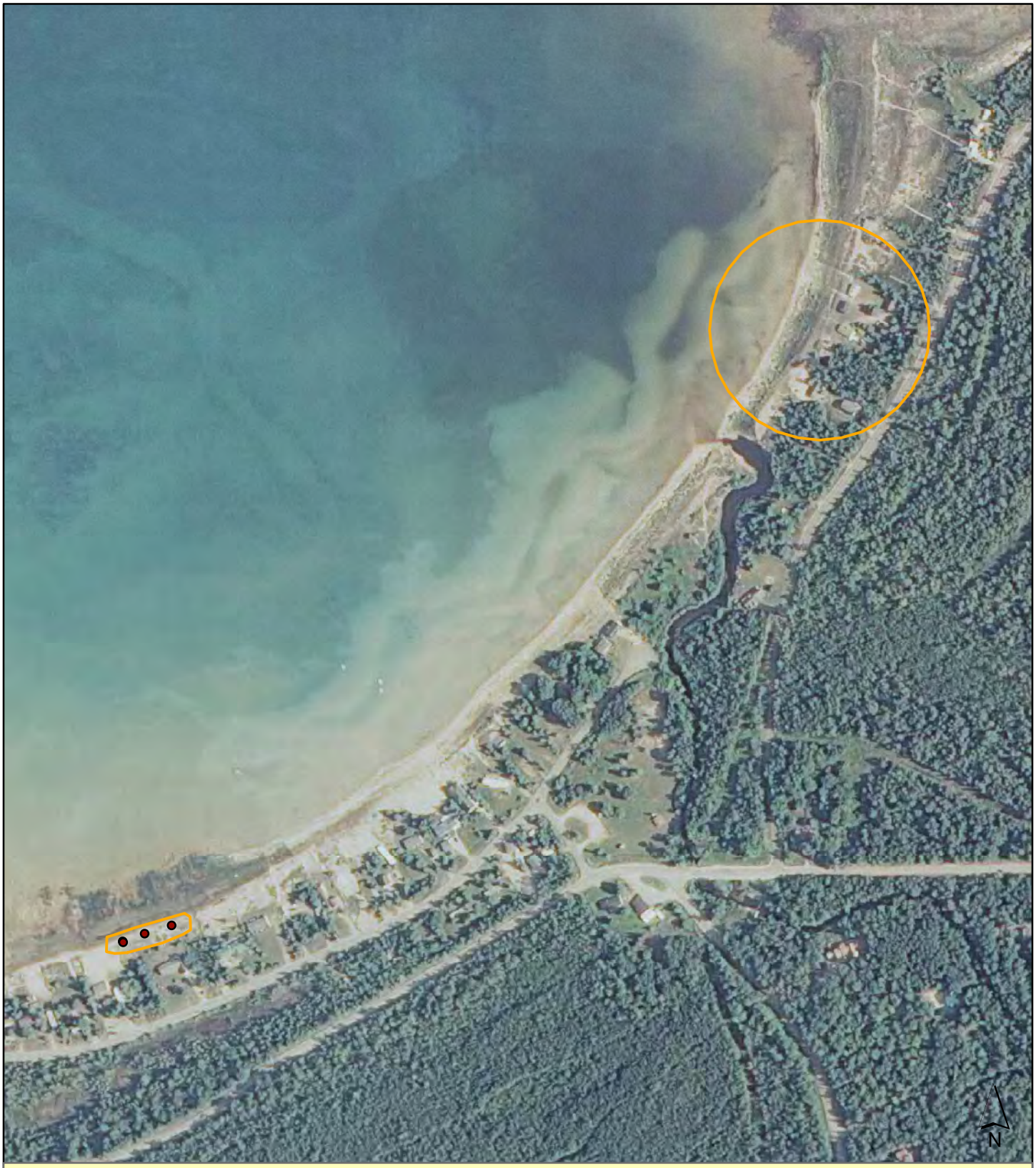
Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Cecil Bay

EO #:	14	**Number of mature plants:**	4
EO ID:	3779	**Number of immature plants:**	5
EO Rank 2011-PRE:	C	**Occupied acreage:**	8.1
EO Rank new:	D	*Survey date:*	*2013-06-28*

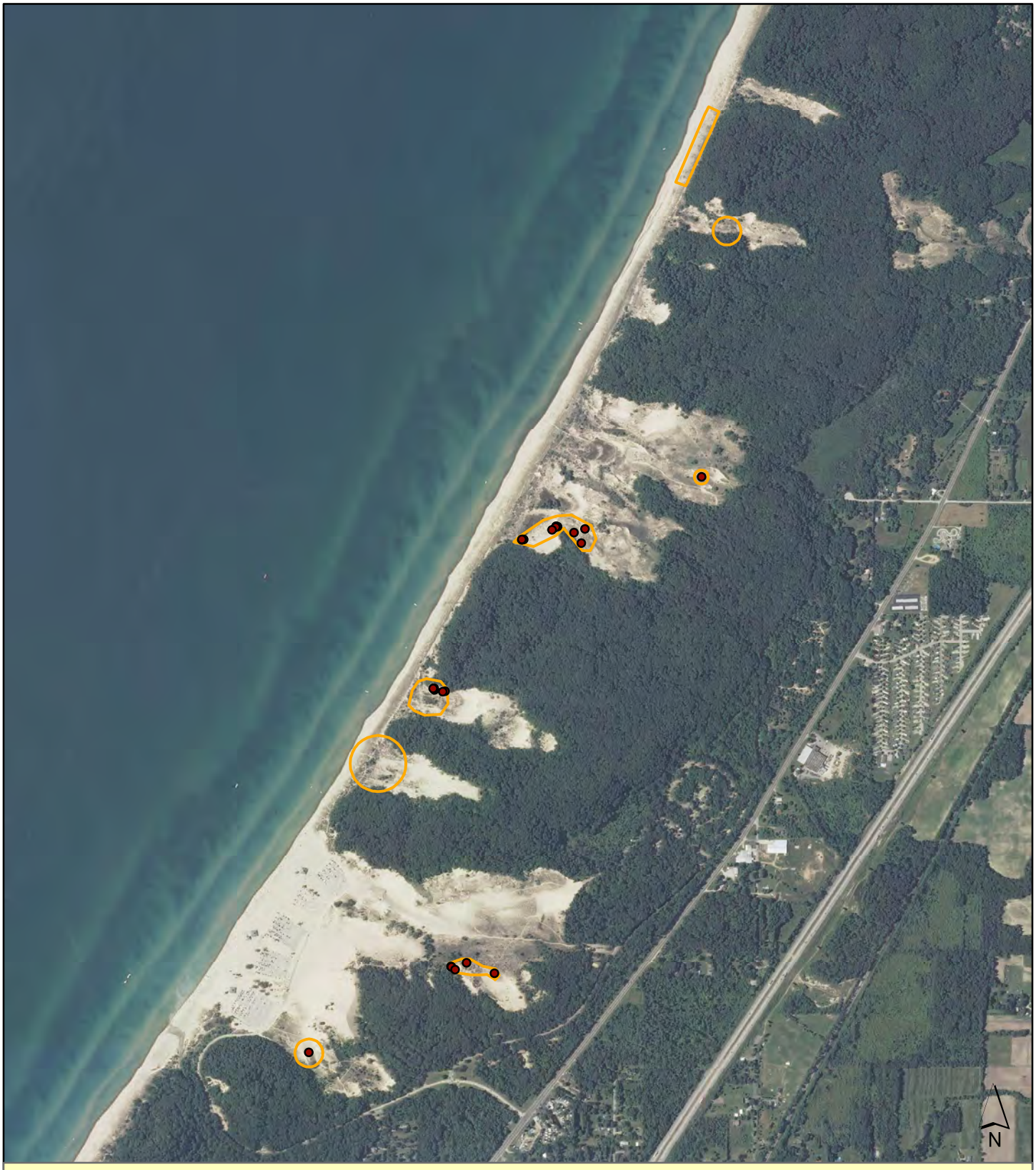
Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Warren Dunes State Park

EO #: 16
EO ID: 6470
EO Rank 2011-PRE: BC
EO Rank new: CD

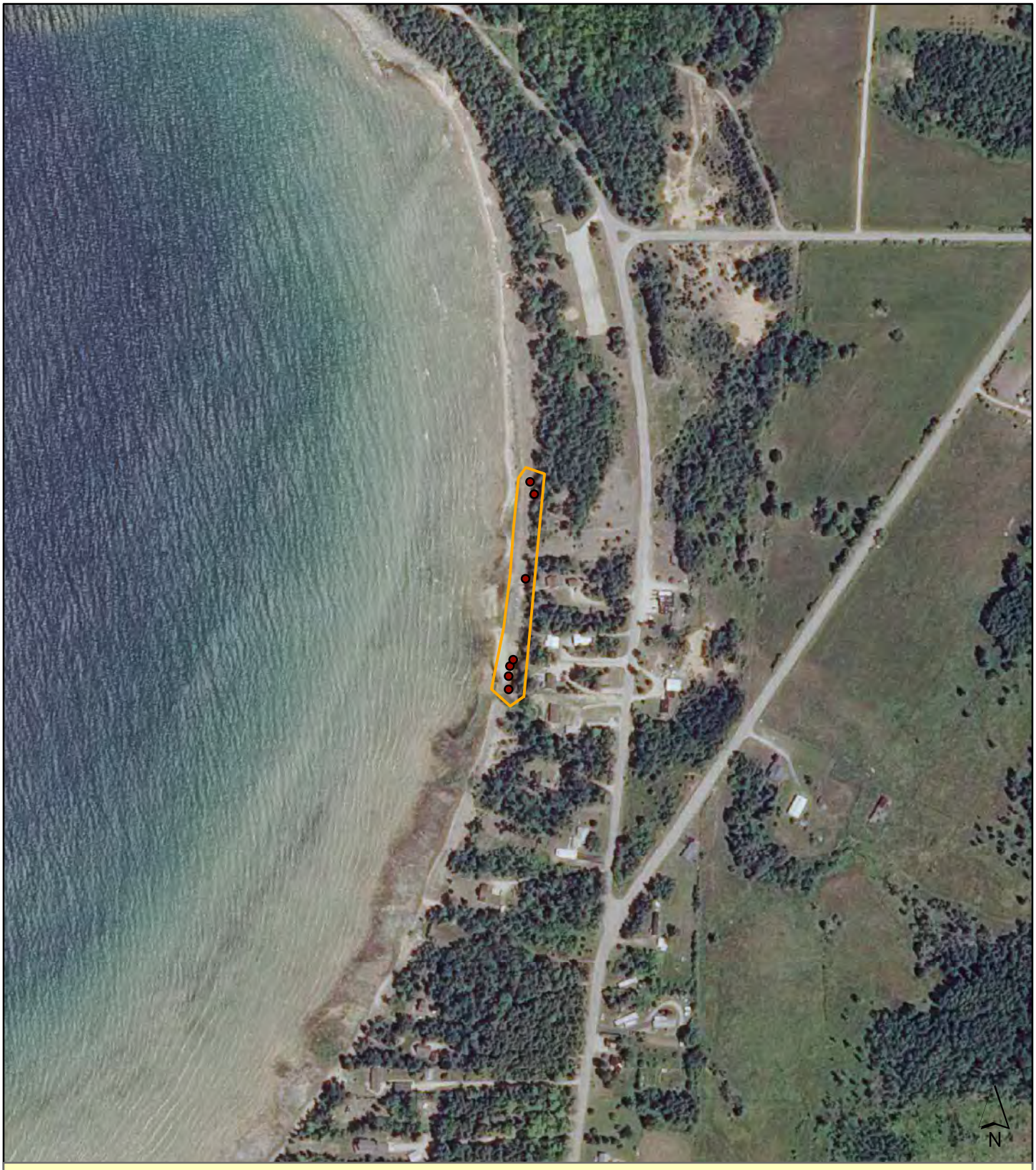
Number of mature plants: 9
Number of immature plants: 39
Occupied acreage: 25.1
Survey date: 2014-07-02

Field GPS points
Occupied acreage

975
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Fayette State Park S

EO #: 18
EO ID: 11365
EO Rank 2011-PRE: CD
EO Rank new: D

Number of mature plants: 2
Number of immature plants: 17
Occupied acreage: 1.3
Survey date: 2016-07-13

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Sturgeon Bay South and Sturgeon Bay Point

EO #: 22
EO ID: 6945
EO Rank 2011-PRE: BC
EO Rank new: AB

Number of mature plants: 6059
Number of immature plants: 6771
Occupied acreage: 190.2
Survey date: 2013-06-28

Field GPS points
Occupied acreage

1,300
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Scott Point to Cozy Point

EO #:	23	**Number of mature plants:**	567
EO ID:	5392	**Number of immature plants:**	1813
EO Rank 2011-PRE:	A	**Occupied acreage:**	14.1
EO Rank new:	BC	*Survey date:*	*2014-08-06*

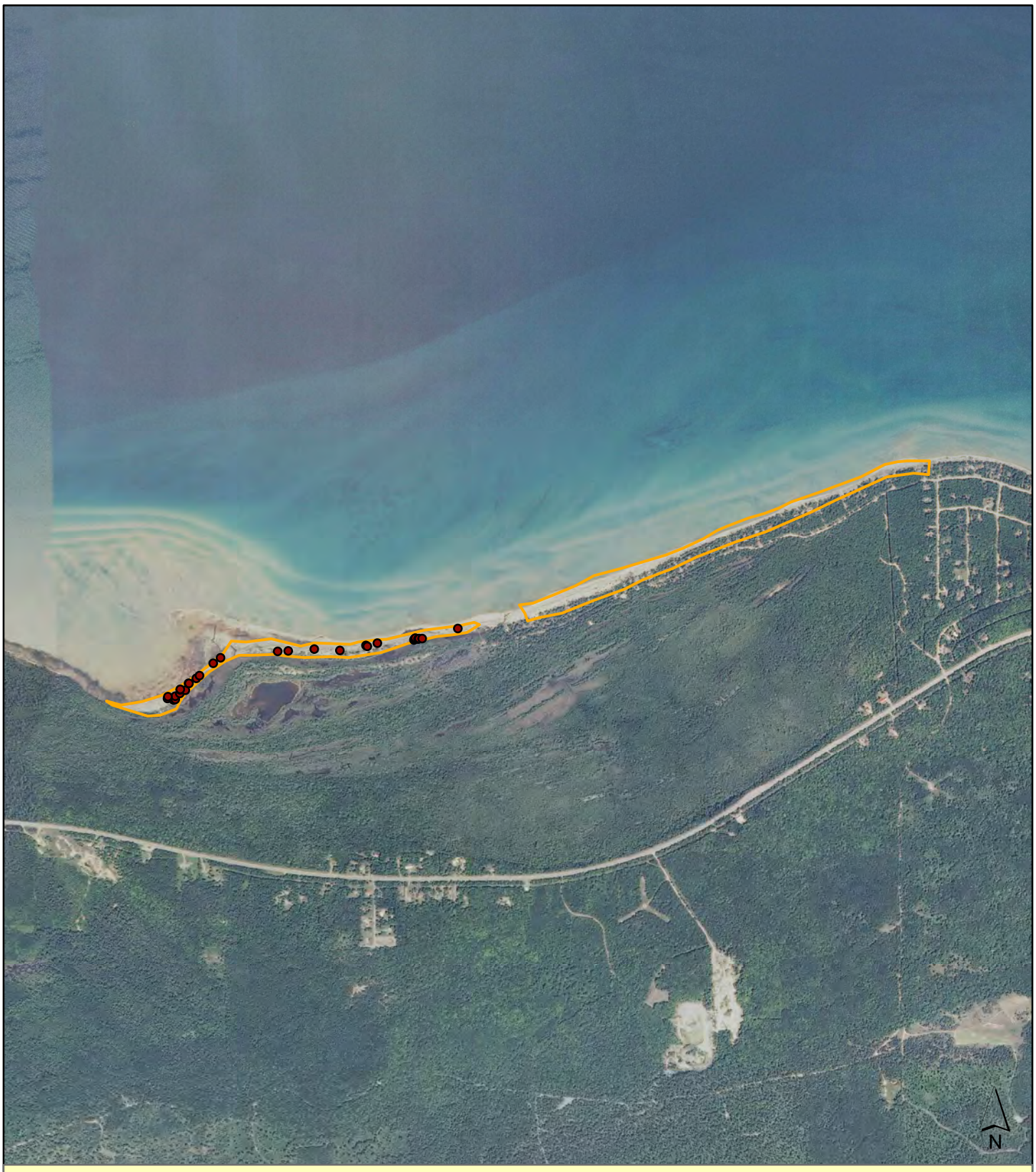
Field GPS points

Occupied acreage

560 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Grass Bay

EO #: 24
EO ID: 6185
EO Rank 2011-PRE: BC
EO Rank new: C

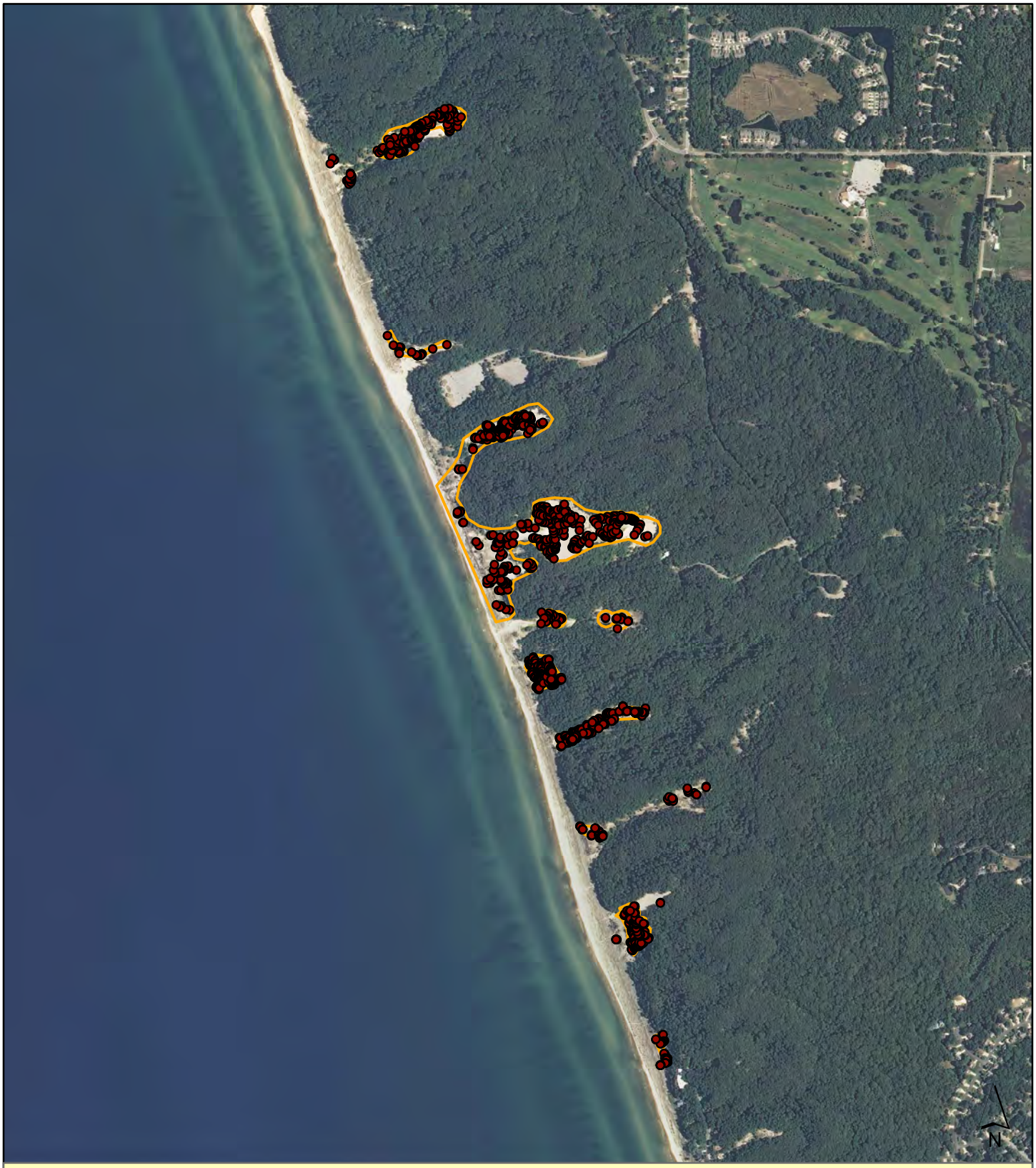
Number of mature plants: 33
Number of immature plants: 26
Occupied acreage: 50.1
Survey date: 2013-07-16

Field GPS points
Occupied acreage

1,100
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Hoffmaster State Park

EO #: 25
EO ID: 12245
EO Rank 2011-PRE: AB
EO Rank new: B

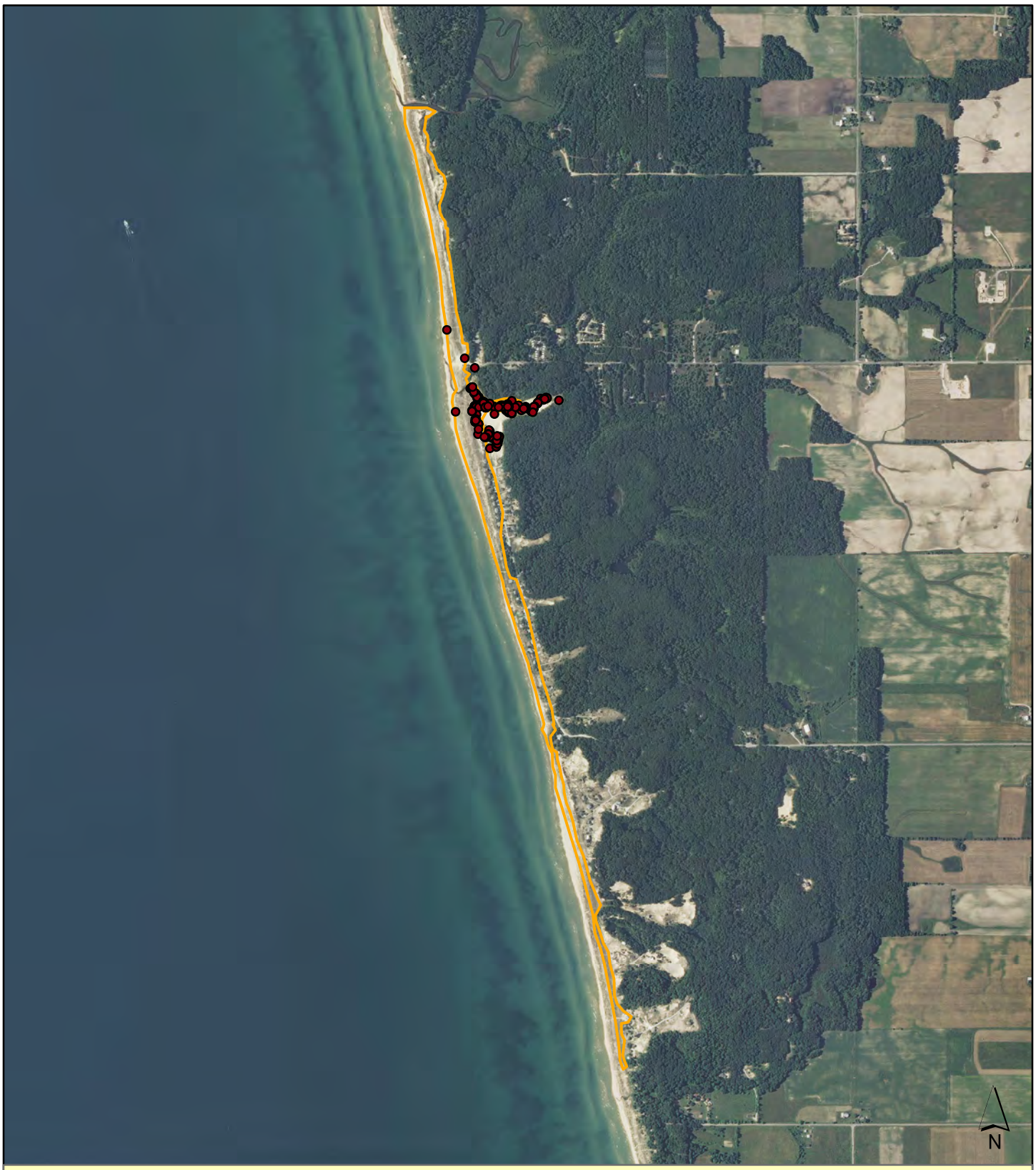
Number of mature plants: 1100
Number of immature plants: 1293
Occupied acreage: 46.4
Survey date: 2013-06-07

Field GPS points
Occupied acreage

850
Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Meinert Park

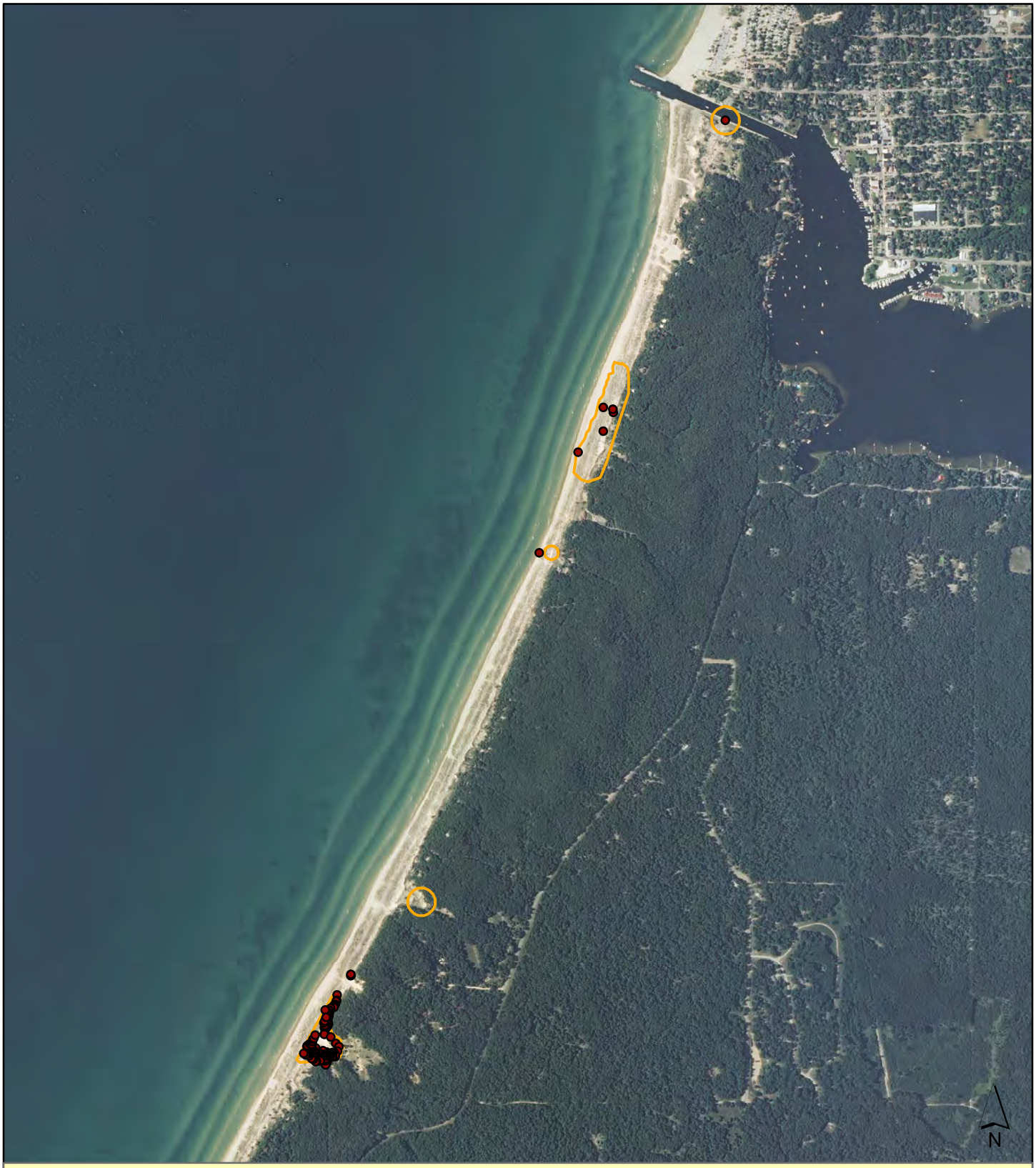
EO #: 26
EO ID: 11826
EO Rank 2011-PRE: C
EO Rank new: C

Number of mature plants: 60
Number of immature plants: 158
Occupied acreage: 55.8
Survey date: 2012-06-21

Field GPS points
Occupied acreage
1,100
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Pentwater Dunes

EO #: 30
EO ID: 13012
EO Rank 2011-PRE: CD
EO Rank new: BC

Number of mature plants: 328
Number of immature plants: 751
Occupied acreage: 19
Survey date: 2013-06-21

Field GPS points
Occupied acreage

990
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Pointe LaBarbe

EO #: 37
EO ID: 8777
EO Rank 2011-PRE: CD
EO Rank new: F

Number of mature plants: 0
Number of immature plants: 0
Occupied acreage: 23.7
Survey date: 2014-07-30

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY | Extension
Michigan Natural Features Inventory

Site Name: Pointe aux Barques

EO #: 40
EO ID: 9410
EO Rank 2011-PRE: BC
EO Rank new: D

Number of mature plants: 0-4
Number of immature plants: 0-4
Occupied acreage: 2.3
Survey date: 2016-08-10

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Gulliver Lake Dunes

EO #: 46
EO ID: 1557
EO Rank 2011-PRE: B
EO Rank new: A

Number of mature plants: 12869
Number of immature plants: 126627
Occupied acreage: 292.2
Survey date: 2016-07-28

Field GPS points
Occupied acreage

3,900
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Pointe aux Chenes

EO #:	49	**Number of mature plants:**	784
EO ID:	3803	**Number of immature plants:**	2358
EO Rank 2011-PRE:	AB	**Occupied acreage:**	63.3
EO Rank new:	B	*Survey date:*	*2014-08-04*

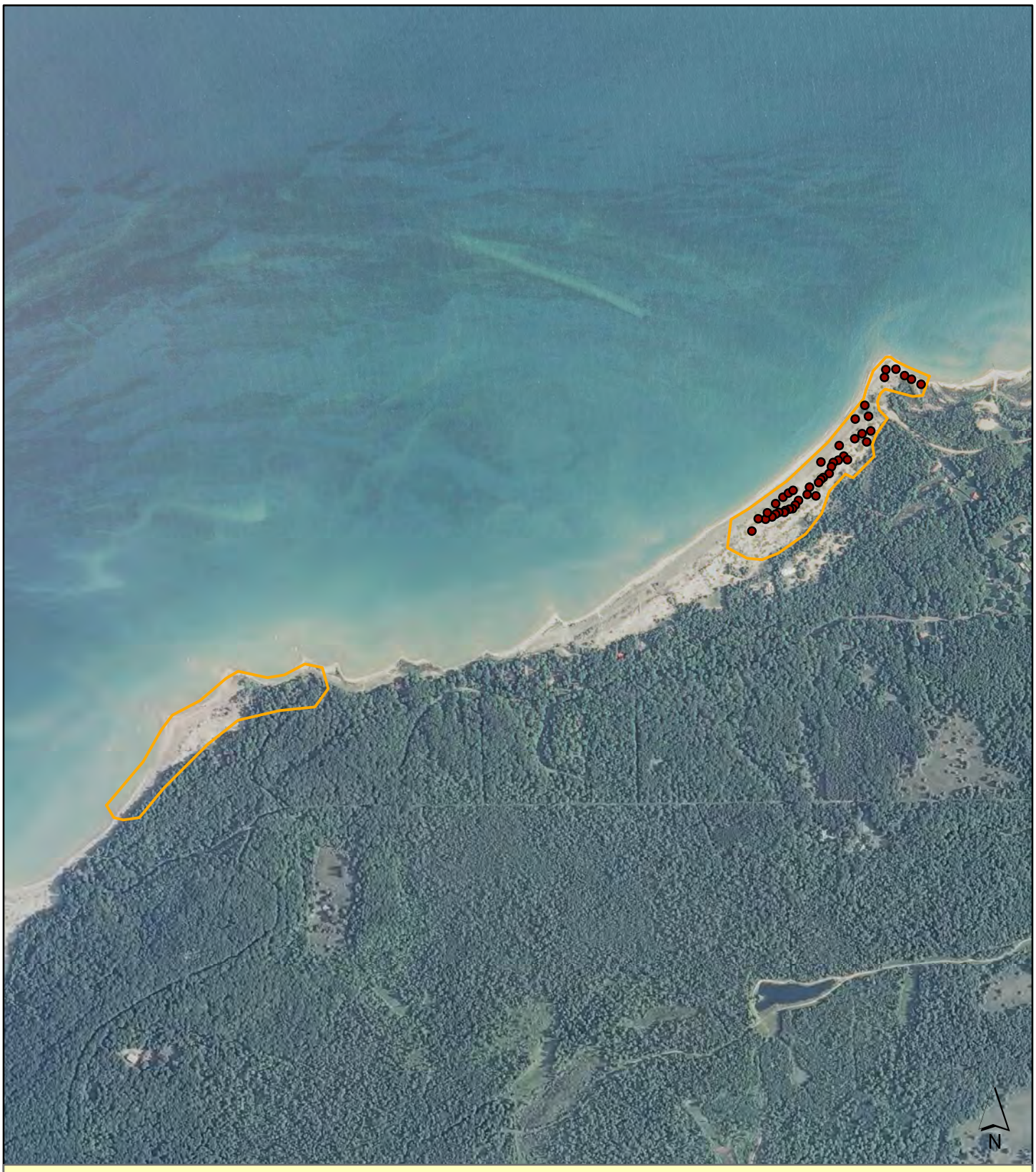
Field GPS points

Occupied acreage

340 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: McCort Hill and Cross Village Beach South

EO #:	50	**Number of mature plants:**	588
EO ID:	3804	**Number of immature plants:**	310
EO Rank 2011-PRE:	C	**Occupied acreage:**	23.7
EO Rank new:	C	*Survey date:*	*2013-06-26*

Field GPS points

Occupied acreage

590 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Hughes Point

EO #:	55	**Number of mature plants:**	1063
EO ID:	1715	**Number of immature plants:**	2352
EO Rank 2011-PRE:	A	**Occupied acreage:**	76
EO Rank new:	B	*Survey date:*	*2014-08-07*

Field GPS points

Occupied acreage

710 Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Stevenson Point, Carl A. Gerstacker Preserve

EO #:	63	**Number of mature plants:**	34
EO ID:	5410	**Number of immature plants:**	32
EO Rank 2011-PRE:	CD	**Occupied acreage:**	2
EO Rank new:	CD	*Survey date:*	*2014-07-11*

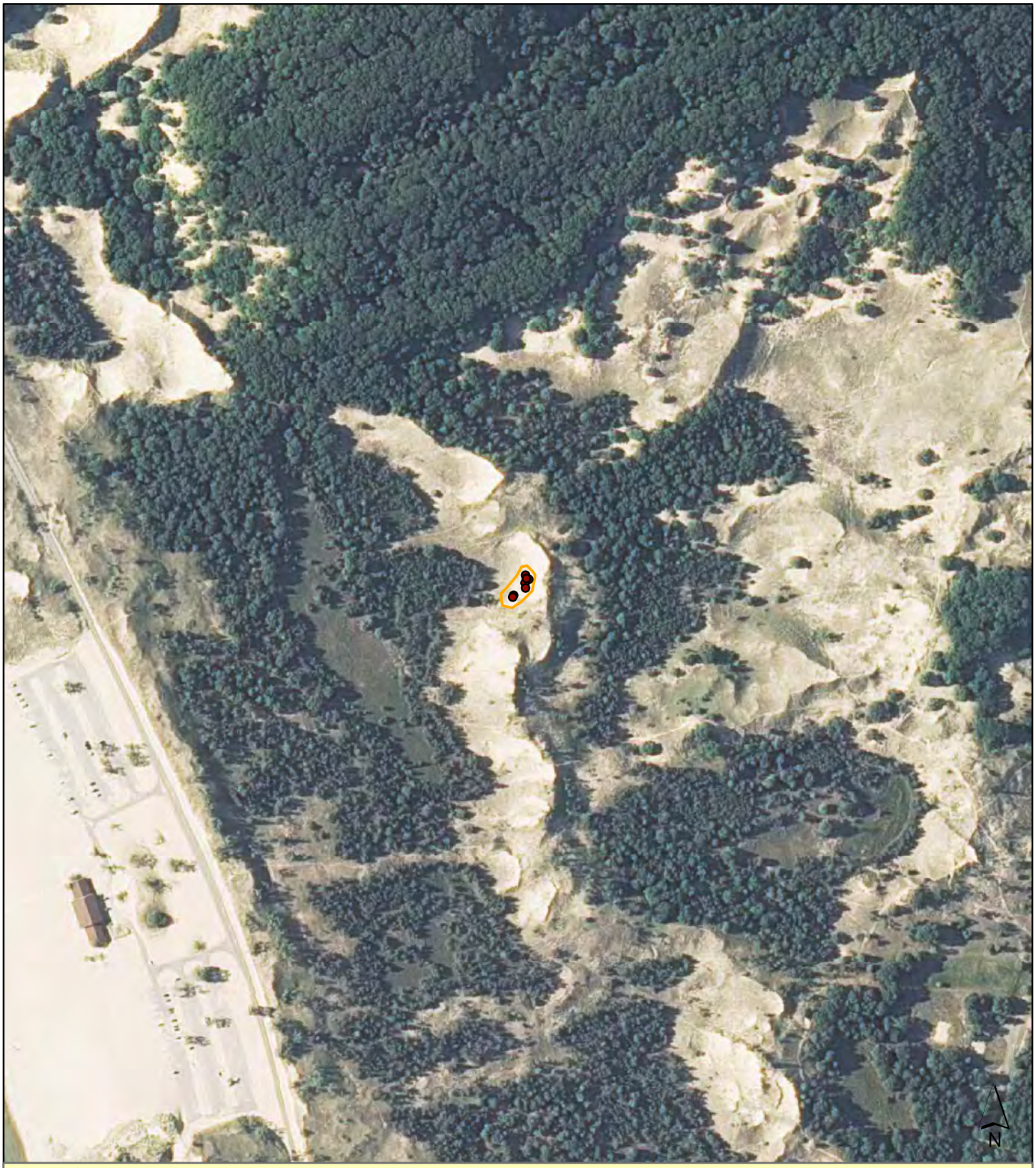
Field GPS points

Occupied acreage

400 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Muskegon State Park

EO #:	64	**Number of mature plants:**	6
EO ID:	9752	**Number of immature plants:**	2
EO Rank 2011-PRE:	C	**Occupied acreage:**	0.2
EO Rank new:	D	*Survey date:*	*2012-07-24*

Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Wilderness Park Drive W

EO #: 66
EO ID: 13100
EO Rank 2011-PRE: C
EO Rank new: D

Number of mature plants: 5
Number of immature plants: 4
Occupied acreage: 1.7
Survey date: 2013-06-28

Field GPS points
Occupied acreage

250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: St. Vital Bay

EO #: 67
EO ID: 8260
EO Rank 2011-PRE: BC
EO Rank new: B

Number of mature plants: 1064
Number of immature plants: 4361
Occupied acreage: 39.5
Survey date: 2014-07-08

Field GPS points
Occupied acreage

640
Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: High Island Bay

EO #:	68	**Number of mature plants:**	261
EO ID:	4988	**Number of immature plants:**	1526
EO Rank 2011-PRE:	C	**Occupied acreage:**	34
EO Rank new:	B	*Survey date:*	*2015-08-12*

Field GPS points

Occupied acreage

710 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Albany Creek Mouth

EO #: 70
EO ID: 9165
EO Rank 2011-PRE: BC
EO Rank new: B

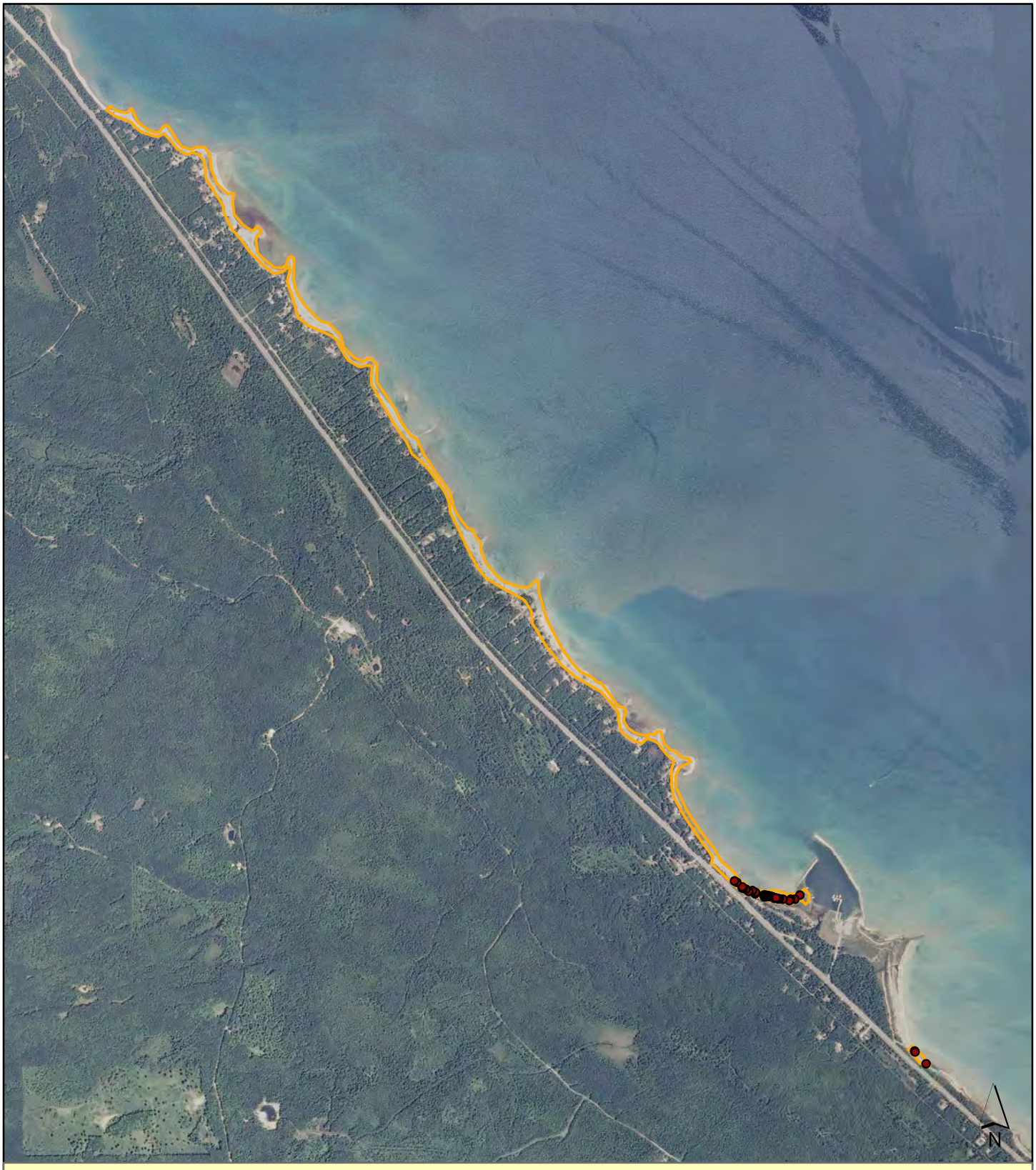
Number of mature plants: 1597
Number of immature plants: 5691
Occupied acreage: 47.2
Survey date: 2014-07-11

Field GPS points
Occupied acreage

1,250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Huron Beach North

EO #:	71	**Number of mature plants:**	32
EO ID:	2329	**Number of immature plants:**	32
EO Rank 2011-PRE:	B	**Occupied acreage:**	43.8
EO Rank new:	C	*Survey date:*	*2013-07-17*

Field GPS points

Occupied acreage

1,200 Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

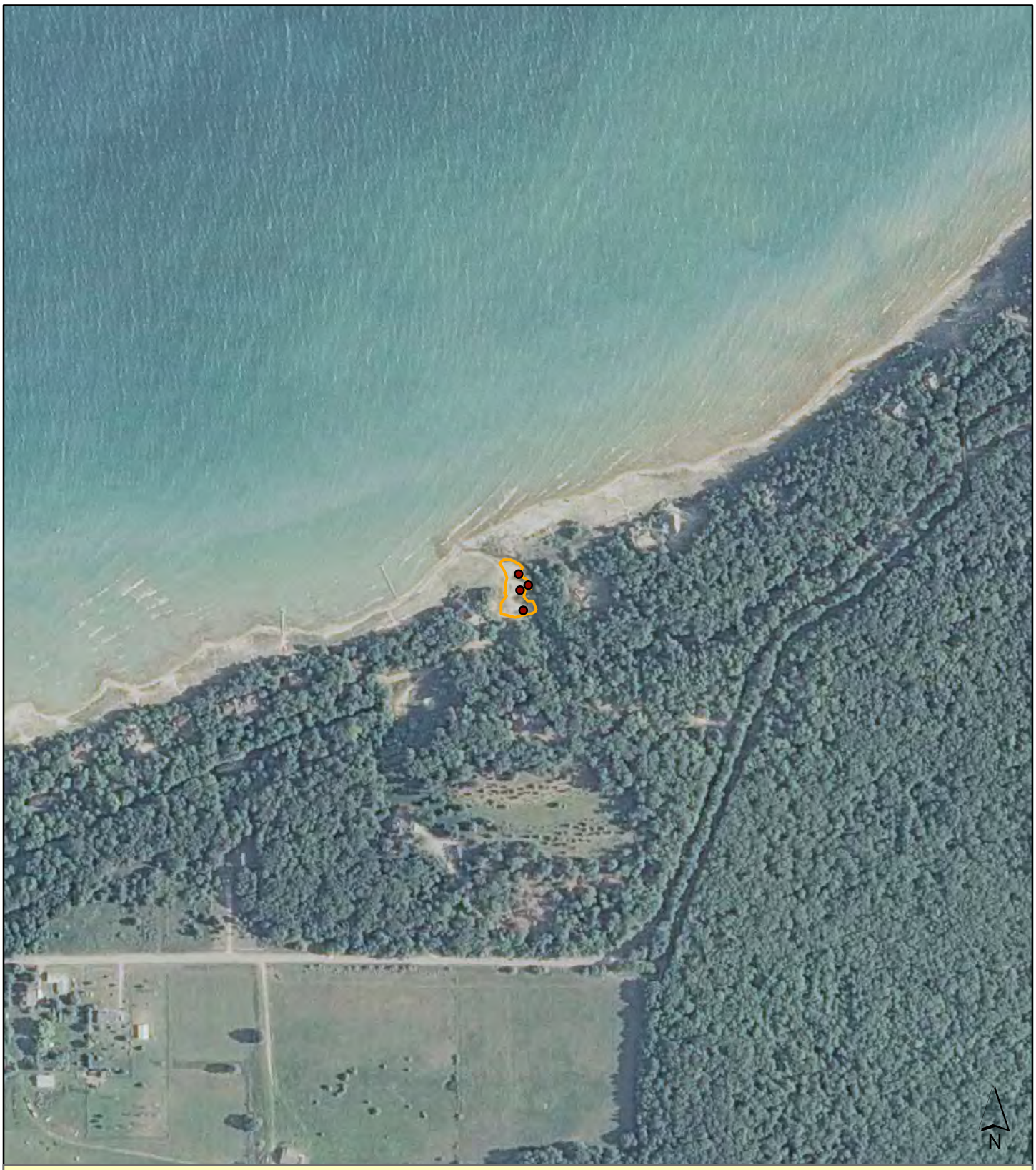
Site Name: Grace North

EO #: 72
EO ID: 9541
EO Rank 2011-PRE: BC
EO Rank new: D

Number of mature plants: 2
Number of immature plants: 2
Occupied acreage: 1.6
Survey date: 2013-07-17

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory



Site Name: Wycamp Creek Mouth

EO #:	73	**Number of mature plants:**	8
EO ID:	7342	**Number of immature plants:**	23
EO Rank 2011-PRE:	C	**Occupied acreage:**	0.3
EO Rank new:	D	*Survey date:*	*2013-06-27*

Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Point Detour

EO #: 74
EO ID: 3001
EO Rank 2011-PRE: CD
EO Rank new: CD

Number of mature plants: 5
Number of immature plants: 62
Occupied acreage: 1.6
Survey date: 2014-08-30

Field GPS points
Occupied acreage
250 Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Fisherman's Island State Park

EO #:	75	**Number of mature plants:**	208
EO ID:	6885	**Number of immature plants:**	213
EO Rank 2011-PRE:	B	**Occupied acreage:**	32
EO Rank new:	C	*Survey date:*	*2013-06-18*

Field GPS points

Occupied acreage

325 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Mt. McSauba Recreational Area

EO #: 77
EO ID: 10443
EO Rank 2011-PRE: BC
EO Rank new: B

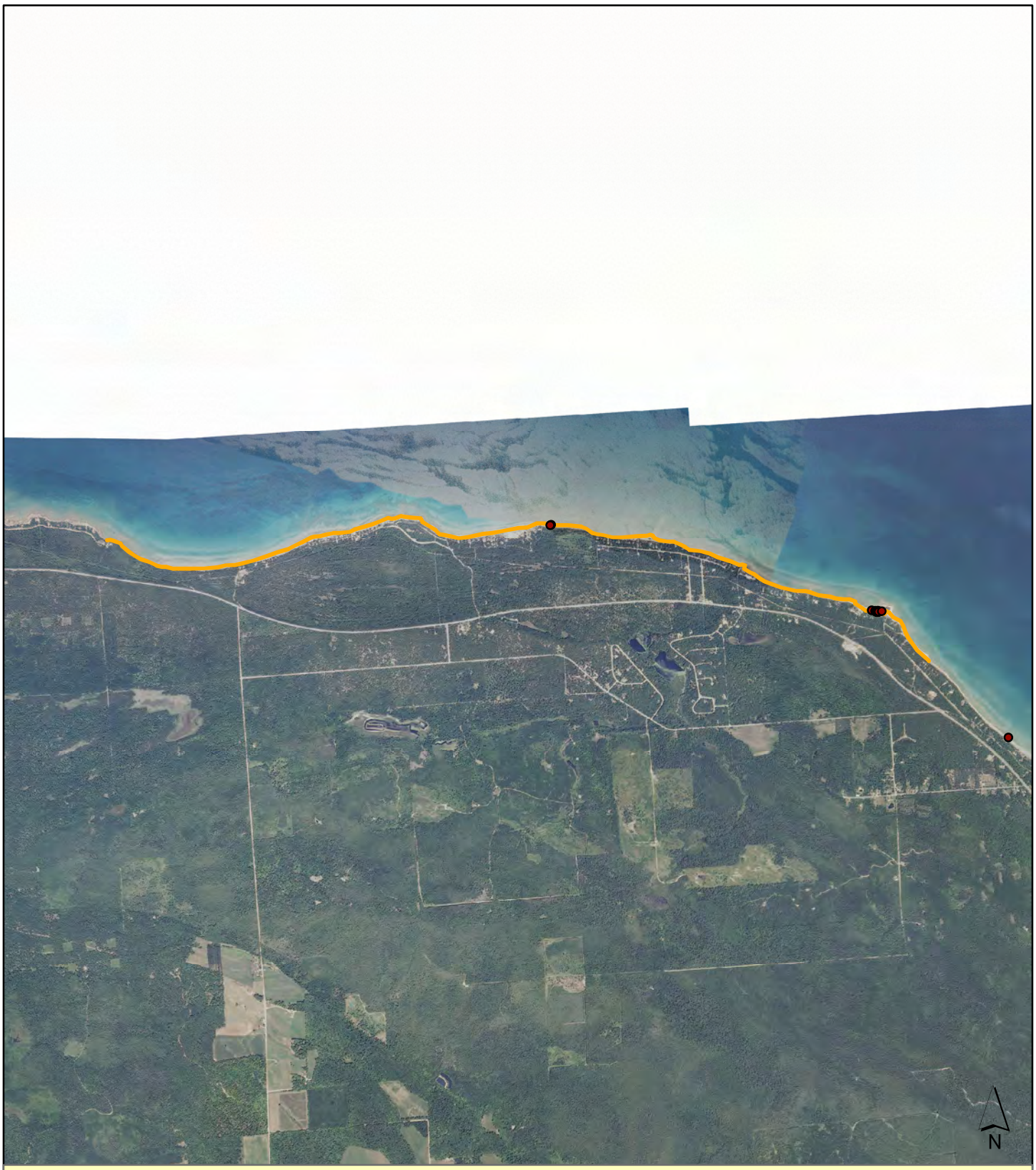
Number of mature plants: 2120
Number of immature plants: 2364
Occupied acreage: 29.8
Survey date: 2013-06-20

Field GPS points
Occupied acreage

320
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Evergreen Beach - 40 Mile Point

EO #:	78	**Number of mature plants:**	14
EO ID:	5038	**Number of immature plants:**	27
EO Rank 2011-PRE:	B	**Occupied acreage:**	28.8
EO Rank new:	C	*Survey date:*	*2013-07-18*

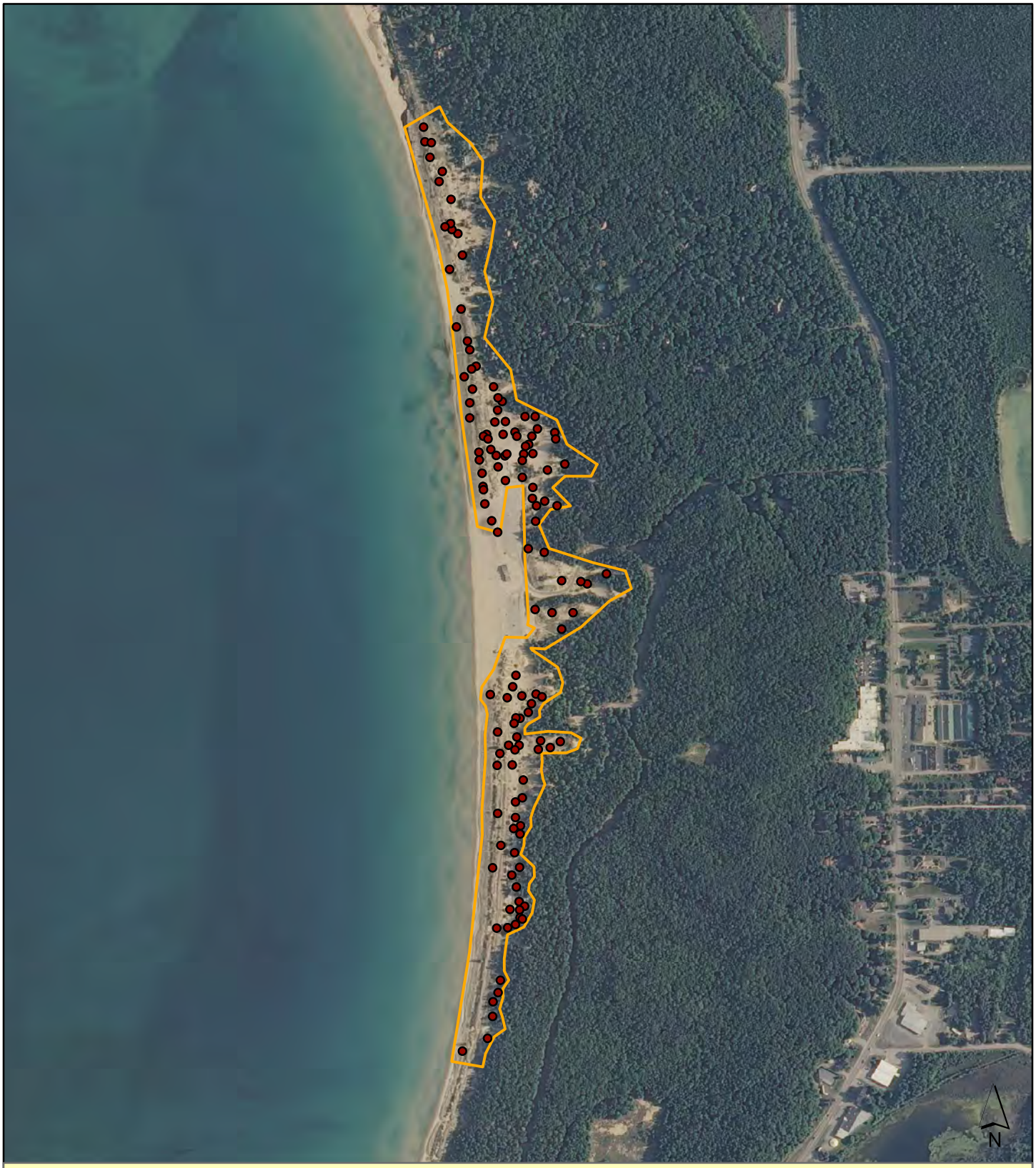
Field GPS points

Occupied acreage

2,700 Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Petoskey State Park and Vicinity

EO #:	79	**Number of mature plants:**	1120
EO ID:	4127	**Number of immature plants:**	1533
EO Rank 2011-PRE:	B	**Occupied acreage:**	53.6
EO Rank new:	B	*Survey date:*	*2013-06-20*

Field GPS points

Occupied acreage

540 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: P.H. Hoeft State Park and Vicinity

EO #:	83	**Number of mature plants:**	598
EO ID:	11827	**Number of immature plants:**	1751
EO Rank 2011-PRE:	B	**Occupied acreage:**	37.6
EO Rank new:	B	*Survey date:*	*2013-08-06*

Field GPS points

Occupied acreage

1,600 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

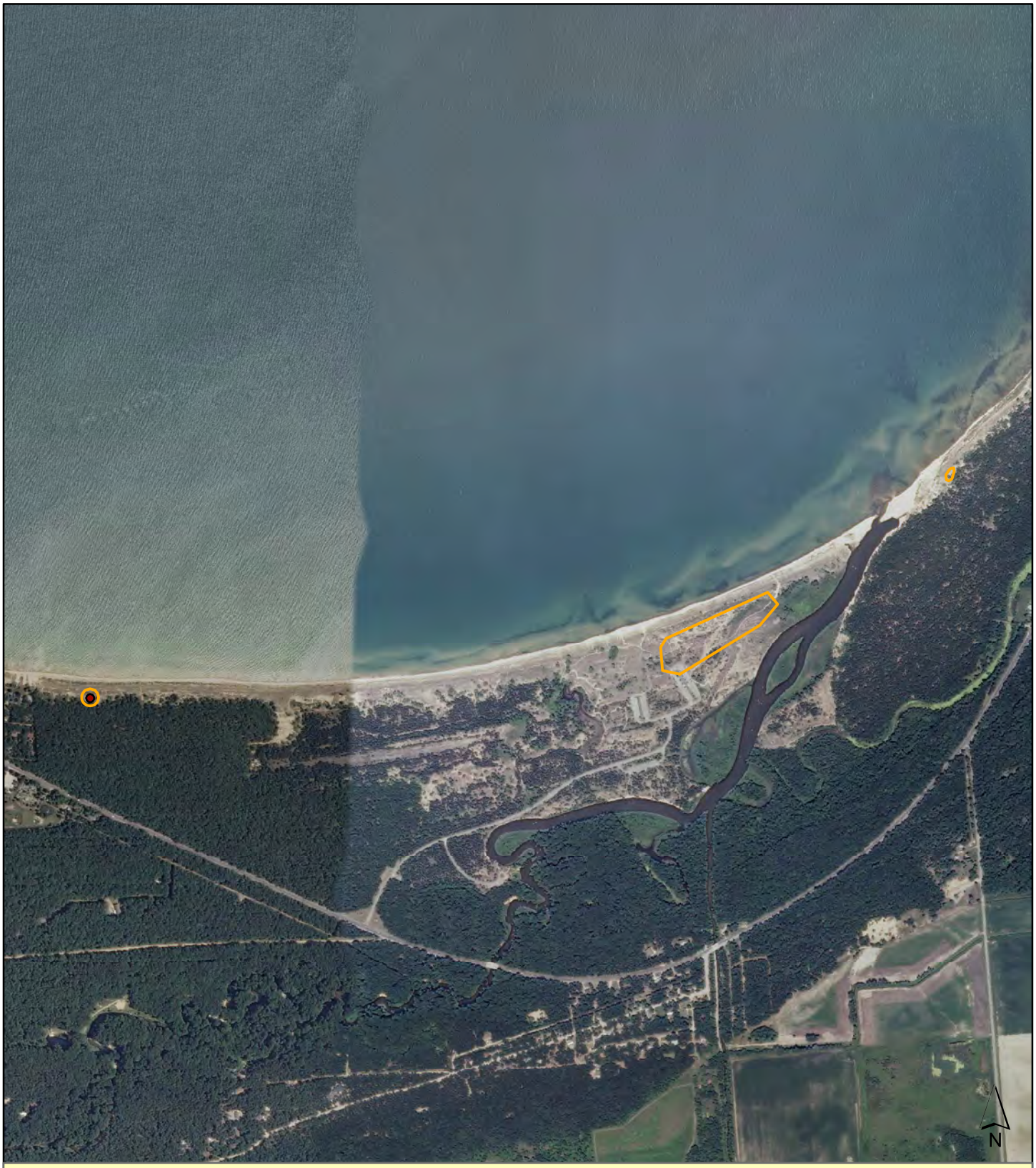
Site Name: Besser Natural Area

EO #: 85
EO ID: 12631
EO Rank 2011-PRE: BC
EO Rank new: D

Number of mature plants: 5
Number of immature plants: 27
Occupied acreage: 1.3
Survey date: 2013-07-19

Field GPS points
Occupied acreage
250 Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory



Site Name: Port Crescent State Park

EO #: 89
EO ID: 3835
EO Rank 2011-PRE: CD
EO Rank new: D

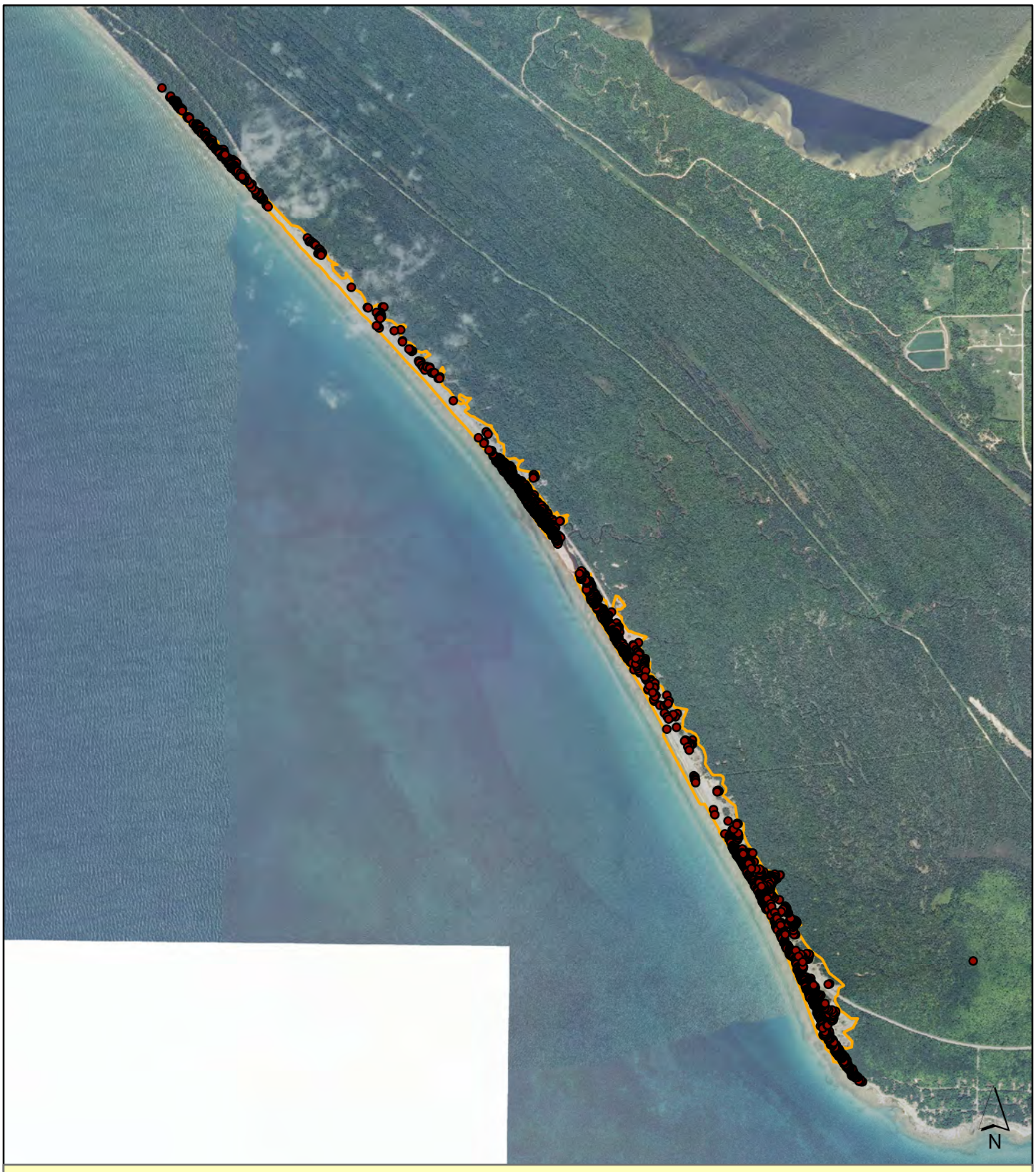
Number of mature plants: 2
Number of immature plants: 0
Occupied acreage: 8.9
Survey date: 2013-06-22

Field GPS points
Occupied acreage

810
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Brevort Dunes

EO #: 90
EO ID: 3832
EO Rank 2011-PRE: A
EO Rank new: AB

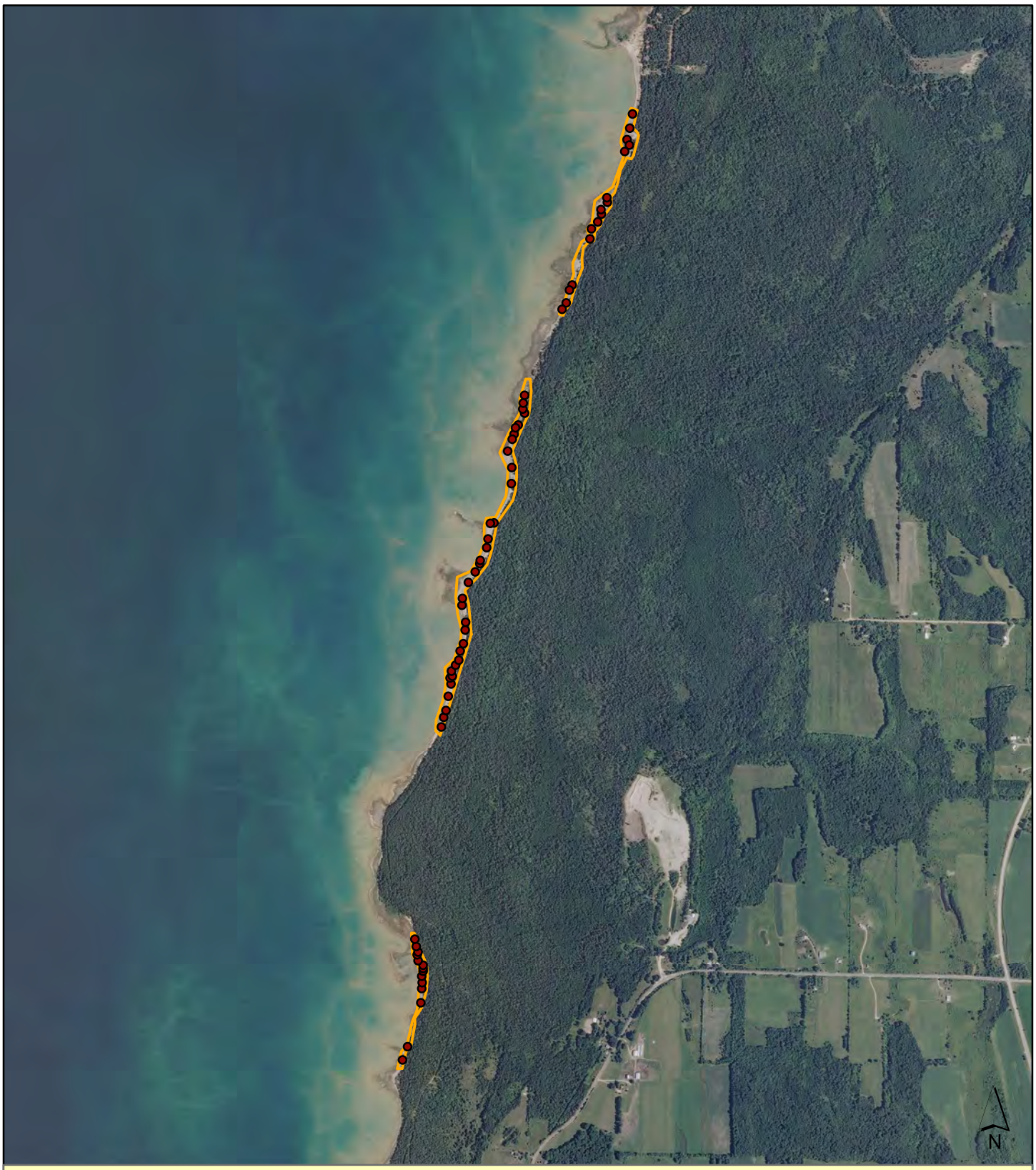
Number of mature plants: 3546
Number of immature plants: 8542
Occupied acreage: 194.6
Survey date: 2014-07-24

Field GPS points
Occupied acreage

1,700
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Norwood North

EO #: 93
EO ID: 4957
EO Rank 2011-PRE: BC
EO Rank new: BC

Number of mature plants: 163
Number of immature plants: 332
Occupied acreage: 29.7
Survey date: 2013-06-18

Field GPS points
Occupied acreage
1,200 Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Mackinaw City

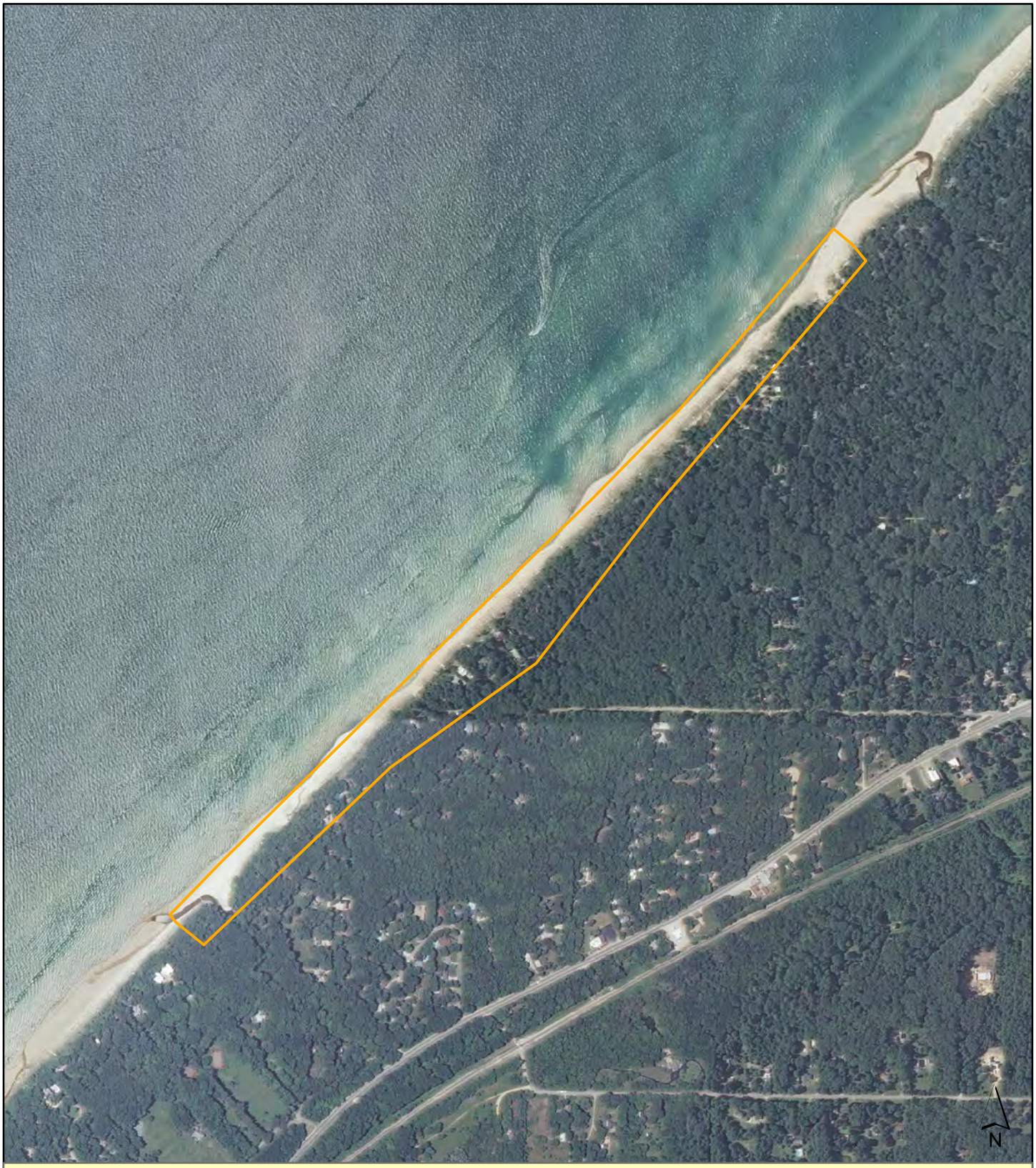
EO #:	94	**Number of mature plants:**	0
EO ID:	6657	**Number of immature plants:**	0
EO Rank 2011-PRE:	H	**Occupied acreage:**	0
EO Rank new:	X	*Survey date:*	*2013-07-15*

Field GPS points

875 Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Harbert

EO #: 97
EO ID: 5588
EO Rank 2011-PRE: H
EO Rank new: H

Number of mature plants: 0
Number of immature plants: 0
Occupied acreage: 56
Survey date: 2013-06-10

Field GPS points
Occupied acreage

570 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Cataract River, Crow River

EO #:	100	**Number of mature plants:**	820
EO ID:	3833	**Number of immature plants:**	1258
EO Rank 2011-PRE:	B	**Occupied acreage:**	51.5
EO Rank new:	B	*Survey date:*	*2014-07-30*

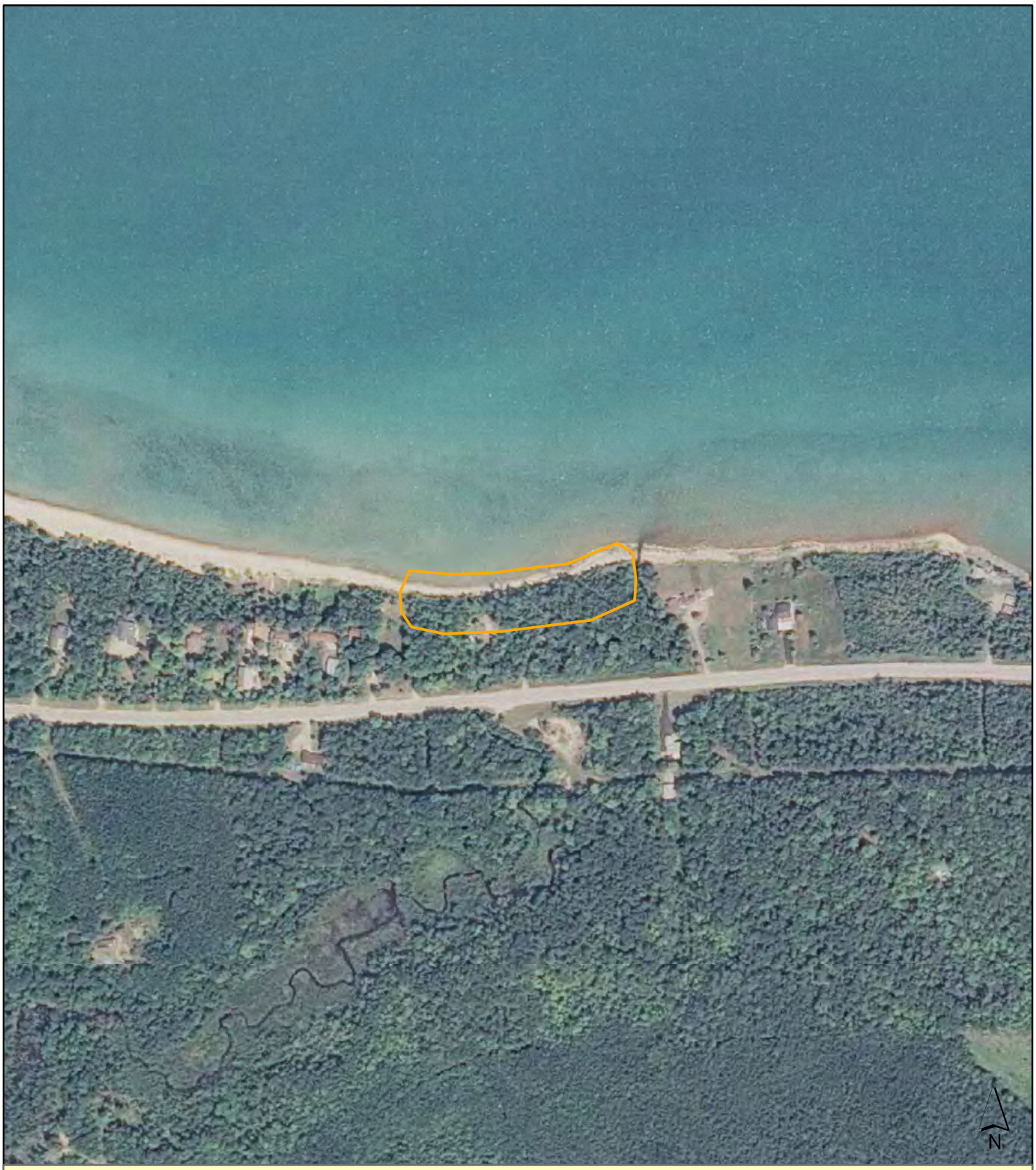
Field GPS points

Occupied acreage

1,600 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Nine Mile Point

EO #:	102	**Number of mature plants:**	0
EO ID:	6494	**Number of immature plants:**	0
EO Rank 2011-PRE:	C	**Occupied acreage:**	2.9
EO Rank new:	F	*Survey date:*	*2013-07-17*

Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Harbor Point

EO #:	103	**Number of mature plants:**	18
EO ID:	4958	**Number of immature plants:**	21
EO Rank 2011-PRE:	H	**Occupied acreage:**	1.8
EO Rank new:	D	*Survey date:*	*2013-06-21*

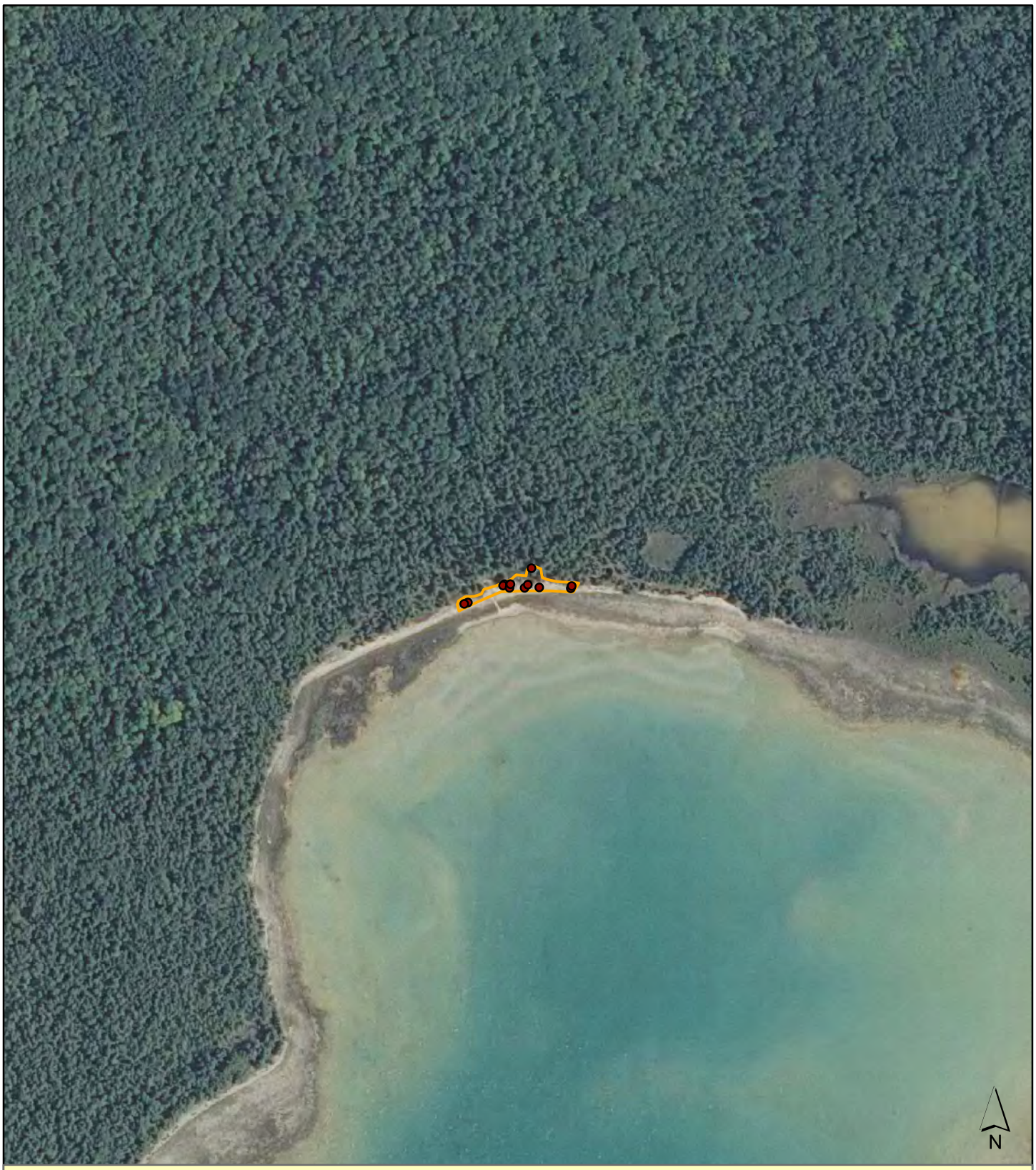
Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Northcutt Bay

EO #: 105
EO ID: 2331
EO Rank 2011-PRE: CD
EO Rank new: D

Number of mature plants: 0
Number of immature plants: 22
Occupied acreage: 0.3
Survey date: 2015-08-11

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Cheboygan State Park

EO #: 106
EO ID: 10805
EO Rank 2011-PRE: C
EO Rank new: CD

Number of mature plants: 13
Number of immature plants: 30
Occupied acreage: 20.7
Survey date: 2013-07-16

Field GPS points
Occupied acreage

280 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: High Island Dunes

EO #: 108
EO ID: 3890
EO Rank 2011-PRE: AB
EO Rank new: A

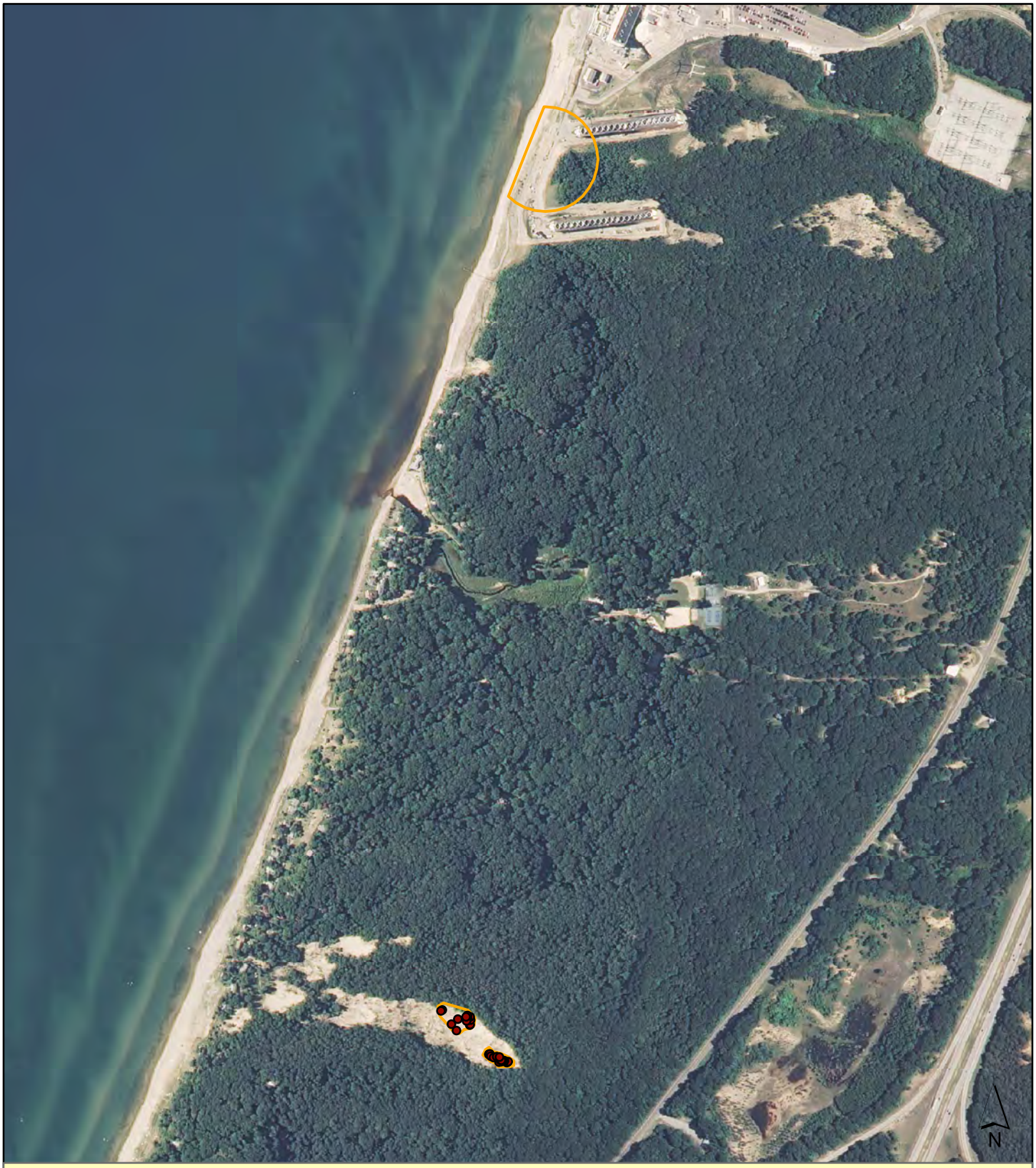
Number of mature plants: 109
Number of immature plants: 768
Occupied acreage: 140
Survey date: 2015-08-10

Field GPS points
Occupied acreage

1,000
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Palisades Park

EO #: 109
EO ID: 12120
EO Rank 2011-PRE: B
EO Rank new: CD

Number of mature plants: 13
Number of immature plants: 68
Occupied acreage: 6.7
Survey date: 2013-07-12

Field GPS points
Occupied acreage
520
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Gilligan Lake Dunes

EO #: 112
EO ID: 11713
EO Rank 2011-PRE: CD
EO Rank new: CD

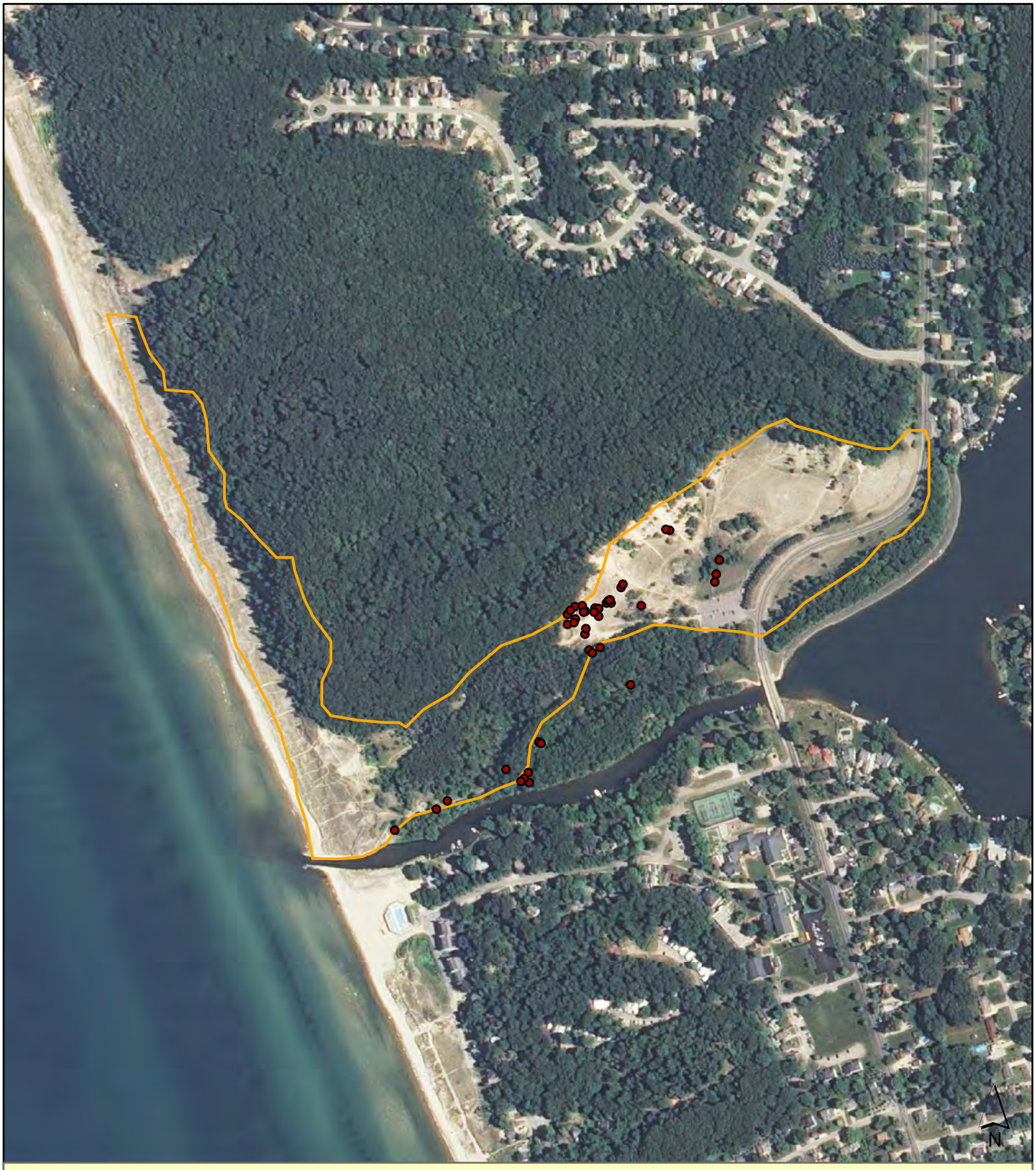
Number of mature plants: 10
Number of immature plants: 37
Occupied acreage: 1.7
Survey date: 2012-08-03

Field GPS points
Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Mona Shores

EO #: 113
EO ID: 4398
EO Rank 2011-PRE: CD
EO Rank new: D

Number of mature plants: 16
Number of immature plants: 5
Occupied acreage: 43.4
Survey date: 2012-06-22

Field GPS points
Occupied acreage

350
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Rosy Mound

EO #: 115
EO ID: 8552
EO Rank 2011-PRE: CD
EO Rank new: BC

Number of mature plants: 156
Number of immature plants: 685
Occupied acreage: 45.4
Survey date: 2012-06-19

Field GPS points
Occupied acreage

250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Silver Lake State Park and Vicinity

EO #: 116
EO ID: 1115
EO Rank 2011-PRE: CD
EO Rank new: C

Number of mature plants: 72
Number of immature plants: 143
Occupied acreage: 85.6
Survey date: 2013-06-14

Field GPS points
Occupied acreage
430
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Thorne Swift Nature Preserve

EO #:	119	**Number of mature plants:**	113
EO ID:	9139	**Number of immature plants:**	68
EO Rank 2011-PRE:	C	**Occupied acreage:**	3.5
EO Rank new:	C	*Survey date:*	*2013-06-24*

Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Johnson Point (The Headlands)

EO #: 121
EO ID: 6804
EO Rank 2011-PRE: CD
EO Rank new: F

Number of mature plants: 0
Number of immature plants: 0
Occupied acreage: 14.8
Survey date: 2013-06-28

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Manitou Payment Highbanks

EO #: 124
EO ID: 3843
EO Rank 2011-PRE: D
EO Rank new: F

Number of mature plants: 0
Number of immature plants: 0
Occupied acreage: 2.6
Survey date: 2014-07-29

Field GPS points
Occupied acreage
250 Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Negwegon State Park

EO #:	127	**Number of mature plants:**	0
EO ID:	5778	**Number of immature plants:**	3
EO Rank 2011-PRE:	C	**Occupied acreage:**	1.7
EO Rank new:	D	*Survey date:*	*2013-08-09*

Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Big Knob Campground to McNeil Creek

EO #: 130
EO ID: 1011
EO Rank 2011-PRE: C
EO Rank new: BC

Number of mature plants: 488
Number of immature plants: 1071
Occupied acreage: 16.5
Survey date: 2014-07-31

Field GPS points
Occupied acreage

780 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Seven Mile Point

EO #:	132	**Number of mature plants:**	863
EO ID:	1525	**Number of immature plants:**	485
EO Rank 2011-PRE:	D	**Occupied acreage:**	24.5
EO Rank new:	BC	*Survey date:*	*2013-06-26*

Field GPS points

Occupied acreage

630 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: West Epoufette

EO #: 133
EO ID: 10928
EO Rank 2011-PRE: C
EO Rank new: BC

Number of mature plants: 414
Number of immature plants: 615
Occupied acreage: 20.3
Survey date: 2014-08-31

Field GPS points
Occupied acreage

800
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Middle Village South

EO #: 136
EO ID: 12066
EO Rank 2011-PRE: CD
EO Rank new: F

Number of mature plants: 0
Number of immature plants: 0
Occupied acreage: 5.4
Survey date: 2013-06-25

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY | Extension
Michigan Natural Features Inventory

Site Name: Ferron Point (Rockport North)

EO #: 140
EO ID: 6651
EO Rank 2011-PRE: C
EO Rank new: D

Number of mature plants: 4
Number of immature plants: 14
Occupied acreage: 0.3
Survey date: 2013-07-22

Field GPS points
Occupied acreage
250 Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Old Grade Road (Besser Natural Area South)

EO #:	141	**Number of mature plants:**	0
EO ID:	1871	**Number of immature plants:**	0
EO Rank 2011-PRE:	C	**Occupied acreage:**	2.7
EO Rank new:	F	*Survey date:*	*2013-07-17*

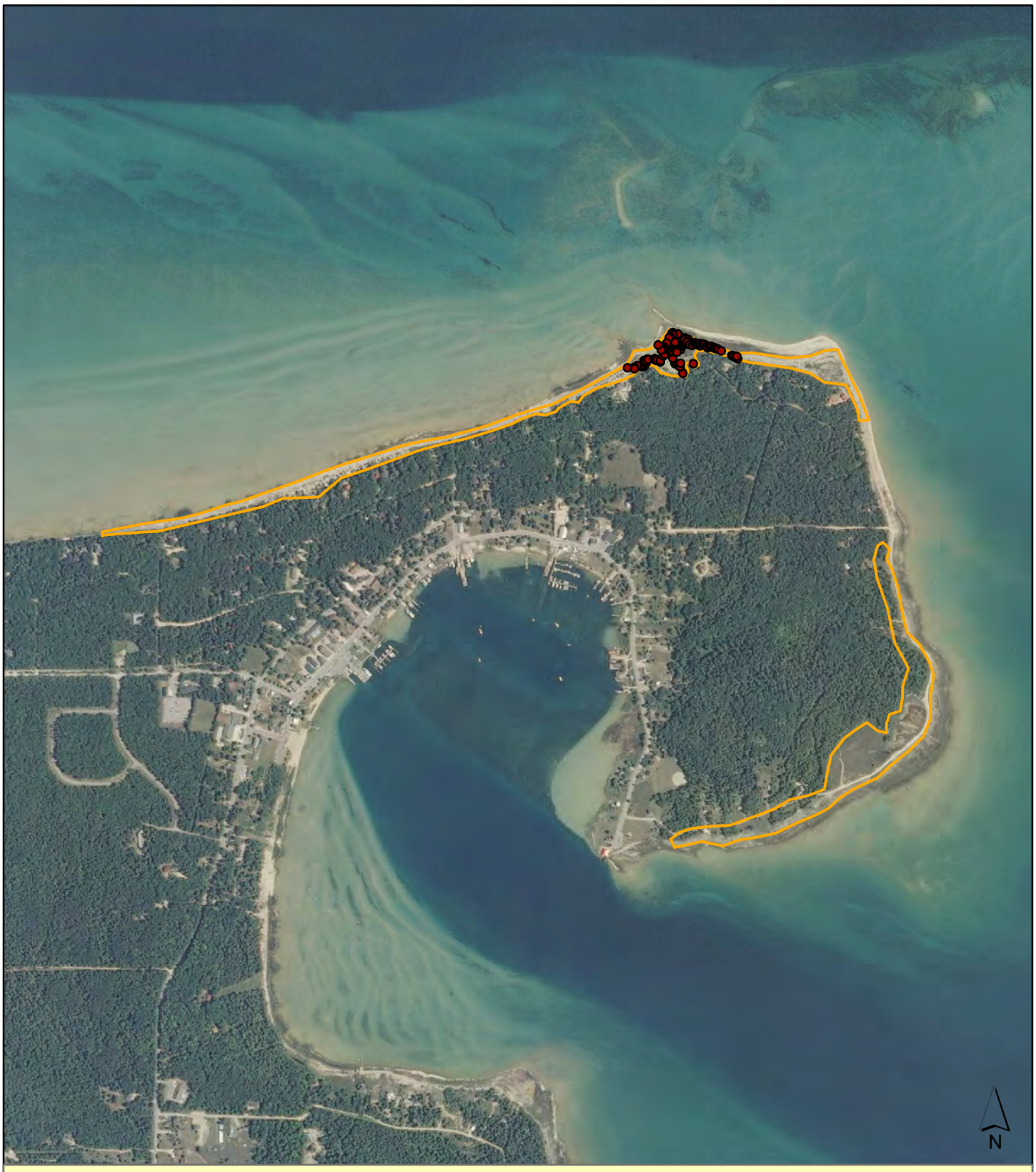
Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Lookout Point

EO #:	143	**Number of mature plants:**	145
EO ID:	5587	**Number of immature plants:**	801
EO Rank 2011-PRE:	B	**Occupied acreage:**	39.7
EO Rank new:	B	*Survey date:*	*2015-08-13*

Field GPS points

Occupied acreage

760 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Snyder Creek, Wiggins Point

EO #: 146
EO ID: 1964
EO Rank 2011-PRE: B
EO Rank new: AB

Number of mature plants: 3132
Number of immature plants: 21130
Occupied acreage: 48.9
Survey date: 2016-08-10

Field GPS points
Occupied acreage

1,100
Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Manistique Township Park

EO #:	148	**Number of mature plants:**	217
EO ID:	2935	**Number of immature plants:**	1974
EO Rank 2011-PRE:	B	**Occupied acreage:**	4.4
EO Rank new:	B	*Survey date:*	*2016-06-23*

Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Section 10 Dunes

EO #: 149
EO ID: 11608
EO Rank 2011-PRE: C
EO Rank new: BC

Number of mature plants: 114
Number of immature plants: 1012
Occupied acreage: 5.1
Survey date: 2016-06-23

Field GPS points
Occupied acreage
300
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Orr Creek

EO #: 150
EO ID: 11609
EO Rank 2011-PRE: C
EO Rank new: B

Number of mature plants: 497
Number of immature plants: 2998
Occupied acreage: 7.3
Survey date: 2016-06-22

Field GPS points
Occupied acreage
290
Meters

MICHIGAN STATE UNIVERSITY Extension
Michigan Natural Features Inventory

Site Name: Manistique Boardwalk

EO #:	151	**Number of mature plants:**	4
EO ID:	1694	**Number of immature plants:**	78
EO Rank 2011-PRE:	C	**Occupied acreage:**	0.3
EO Rank new:	CD	*Survey date:*	*2016-06-20*

Field GPS points

Occupied acreage

250 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Goudreau's Harbor

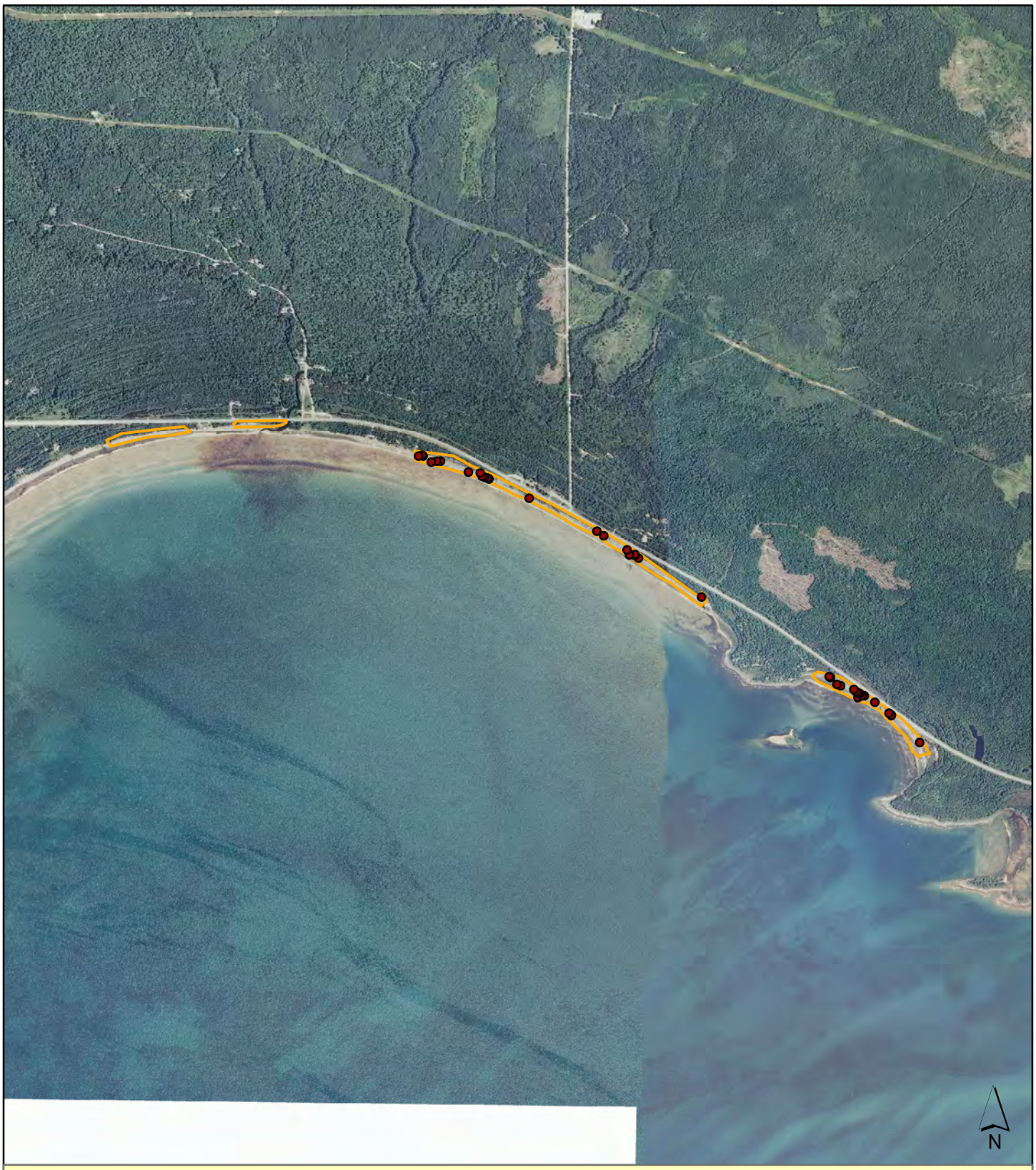
EO #: 155
EO ID: 13002
EO Rank 2011-PRE: C
EO Rank new: C

Number of mature plants: 57
Number of immature plants: 310
Occupied acreage: 2.1
Survey date: 2016-07-28

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Black River Road

EO #:	156	**Number of mature plants:**	62
EO ID:	1914	**Number of immature plants:**	110
EO Rank 2011-PRE:	C	**Occupied acreage:**	39.3
EO Rank new:	C	*Survey date:*	*2014-07-16*

Field GPS points

Occupied acreage

1,500 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Laketown Township Dunes

EO #: 157
EO ID: 10936
EO Rank 2011-PRE: C
EO Rank new: CD

Number of mature plants: 67
Number of immature plants: 56
Occupied acreage: 2.7
Survey date: 2013-05-31

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Grand Marais Beach

EO #: 165
EO ID: 16218
EO Rank 2011-PRE: BC
EO Rank new: C

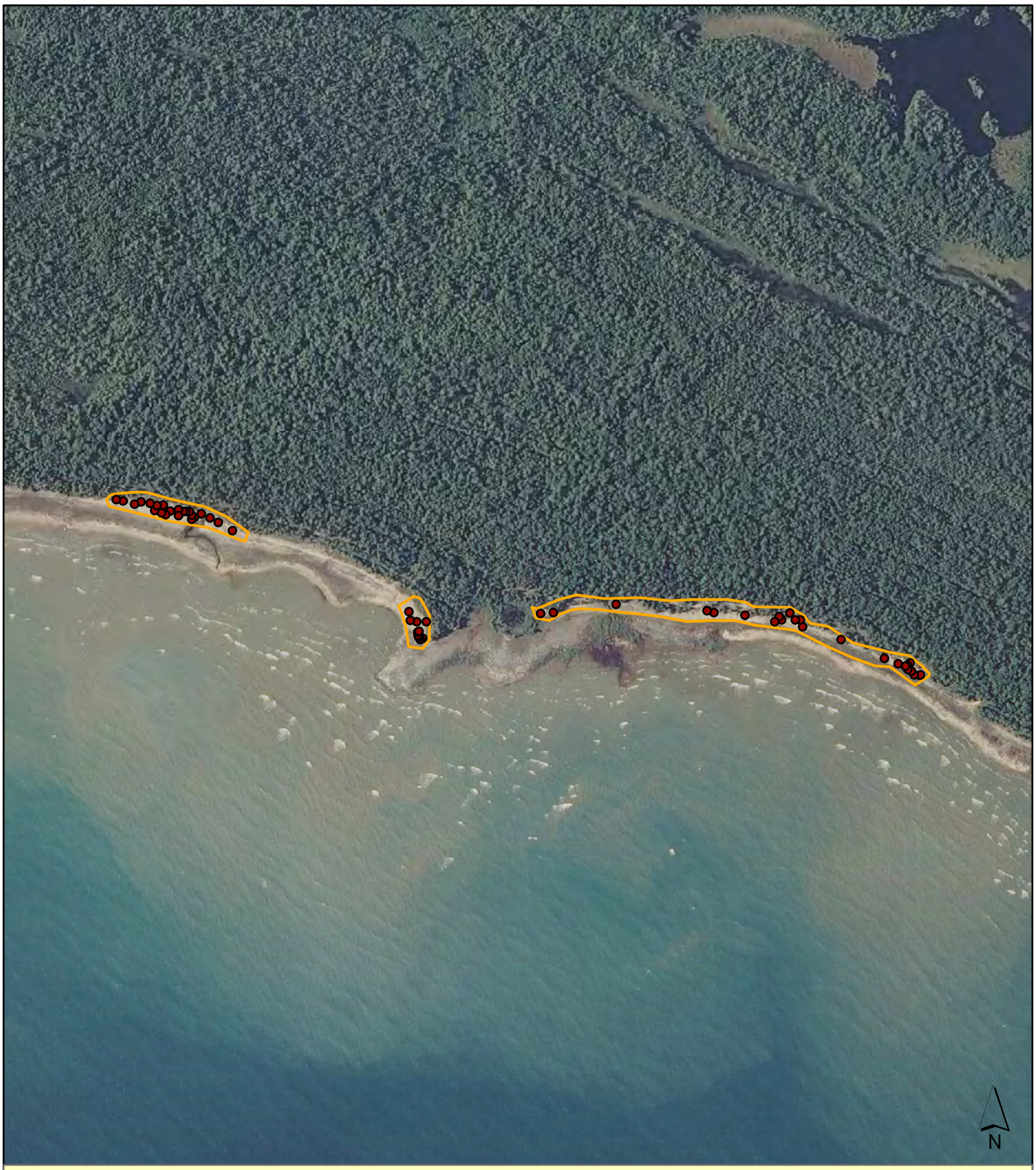
Number of mature plants: 38
Number of immature plants: 894
Occupied acreage: 2.5
Survey date: 2016-08-08

Field GPS points
Occupied acreage

340 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Hudson Creek

EO #: 175
EO ID: 20161
EO Rank 2011-PRE: *
EO Rank new: C

Number of mature plants: 125
Number of immature plants: 383
Occupied acreage: 7.9
Survey date: 2014-08-06

Field GPS points
Occupied acreage

475
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Birch Point to Seiners Point

EO #: 176
EO ID: 20162
EO Rank 2011-PRE: *
EO Rank new: B

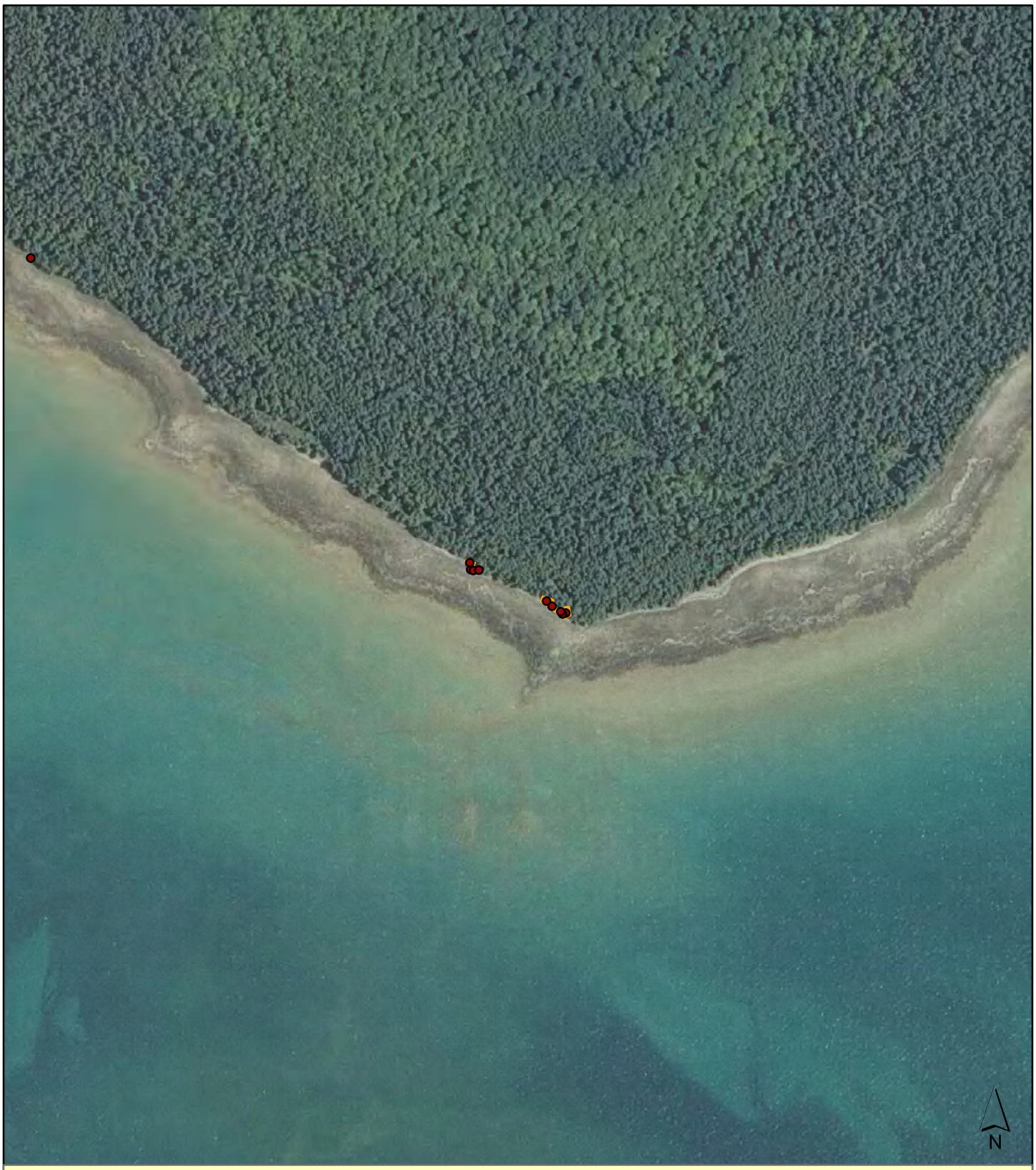
Number of mature plants: 942
Number of immature plants: 7361
Occupied acreage: 19.2
Survey date: 2016-07-29

Field GPS points
Occupied acreage

1,600
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory



Site Name: Garden Island SW

EO #: 177
EO ID: 20511
EO Rank 2011-PRE: *
EO Rank new: D

Number of mature plants: 6
Number of immature plants: 25
Occupied acreage: 0.1
Survey date: 2015-08-11

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Portage Bay Campground

EO #: 178
EO ID: 20856
EO Rank 2011-PRE: *
EO Rank new: BC

Number of mature plants: 169
Number of immature plants: 1050
Occupied acreage: 1.8
Survey date: 2016-07-13

Field GPS points
Occupied acreage
250
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Site Name: Seul Choix Bay

EO #: 179
EO ID: 20866
EO Rank 2011-PRE: *
EO Rank new: BC

Number of mature plants: 103
Number of immature plants: 1852
Occupied acreage: 5.3
Survey date: 2016-07-28

Field GPS points
Occupied acreage

660
Meters

MICHIGAN STATE UNIVERSITY | Extension

Michigan Natural Features Inventory

Appendix 4. Maps and Data for Updated *Asplenium scolopendrium* var. *americanum* EOs.

Site Name: East Lake NE

Survey date: 2016-08-04

EO #:	1	**Number of sporelings:**	6
EO ID:	8467	**Number of mature plants:**	27
EO Rank old:	C	**Number of immature plants:**	46
EO Rank new:	C	**Occupied acreage:**	0.6

Field GPS points

Occupied acreage

200 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory

Site Name: Trout Lake

Survey date: 2016-08-05

EO #:	2	**Number of sporelings:**	0
EO ID:	5767	**Number of mature plants:**	0
EO Rank old:	D	**Number of immature plants:**	0
EO Rank new:	F	**Occupied acreage:**	7.7

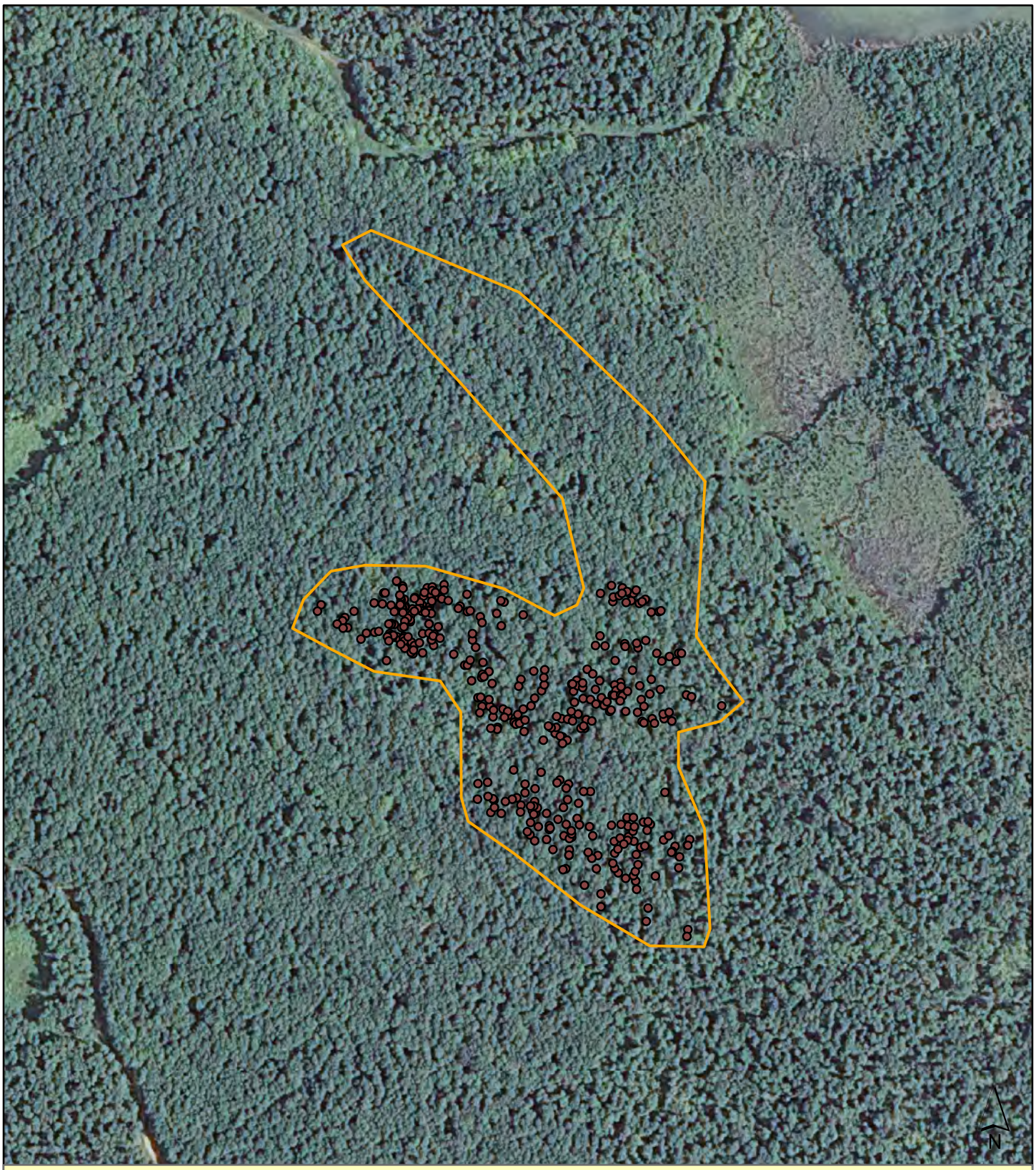
Field GPS points

Occupied acreage

200 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Hill Lake SW

Survey date: 2016-08-18

EO #:	3	**Number of sporelings:**	1451
EO ID:	9605	**Number of mature plants:**	2738
EO Rank old:	A	**Number of immature plants:**	4162
EO Rank new:	A	**Occupied acreage:**	29.4

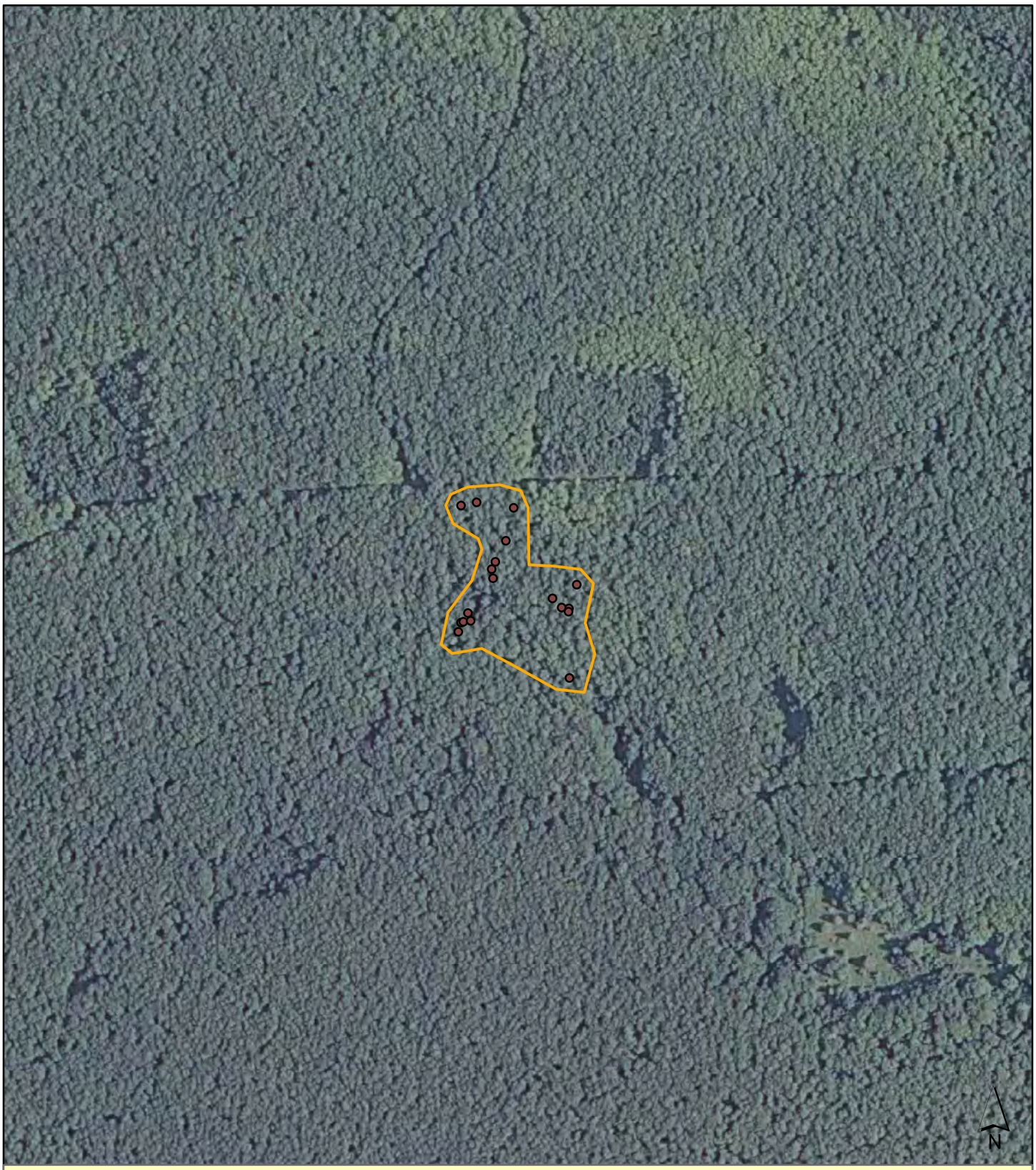
Field GPS points

Occupied acreage

200 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: East Lake SW

Survey date: 2016-08-03

EO #:	4	**Number of sporelings:**	6
EO ID:	1320	**Number of mature plants:**	110
EO Rank old:	B	**Number of immature plants:**	60
EO Rank new:	B	**Occupied acreage:**	4

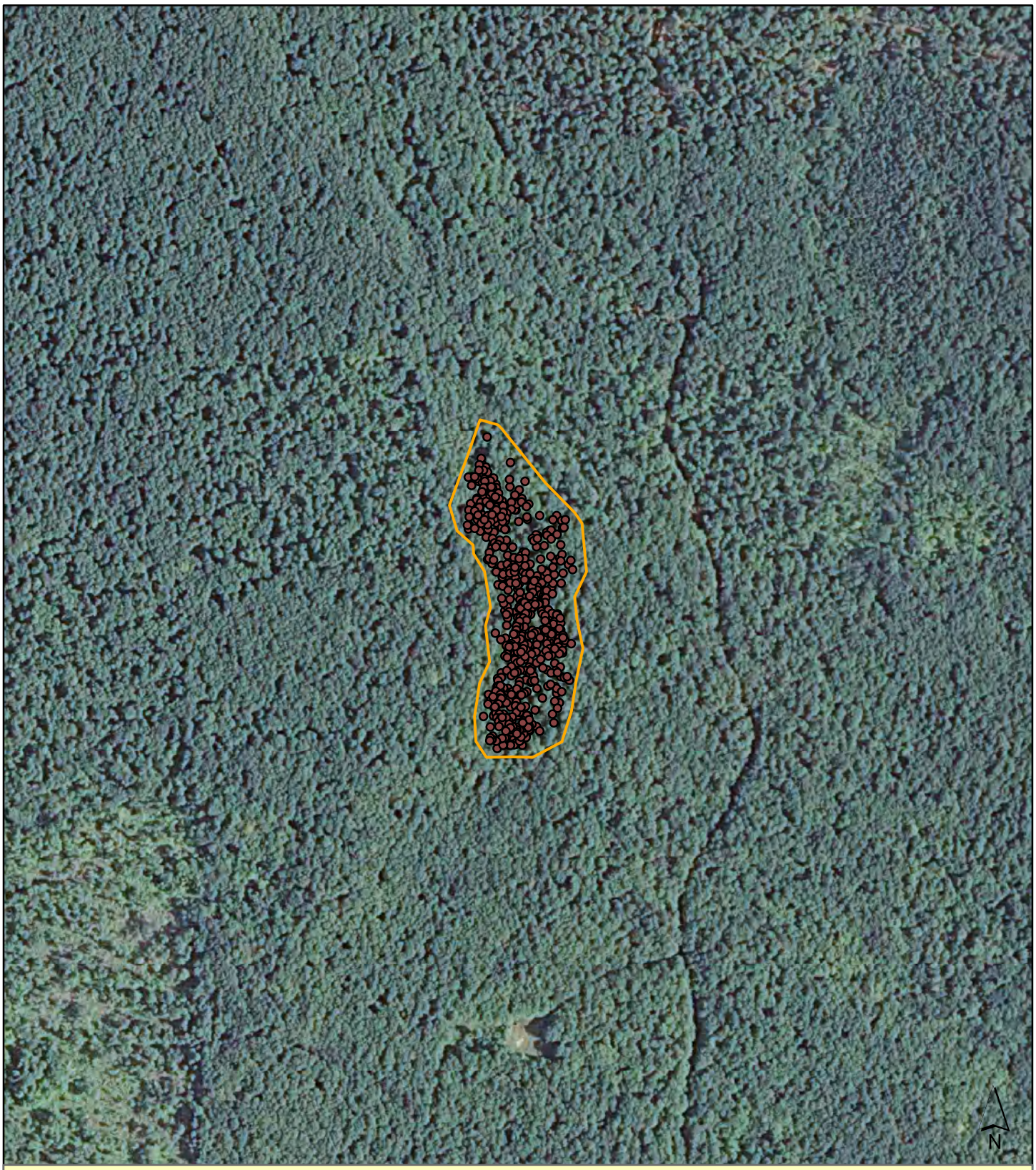
Field GPS points

Occupied acreage

200 Meters

MICHIGAN STATE UNIVERSITY Extension

Michigan Natural Features Inventory



Site Name: Hill Lake E

Survey date: 2016-08-17

EO #:	5	**Number of sporelings:**	289
EO ID:	8956	**Number of mature plants:**	2182
EO Rank old:	A	**Number of immature plants:**	2664
EO Rank new:	A	**Occupied acreage:**	6.4

Field GPS points

Occupied acreage

200 Meters

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Michigan Natural Features Inventory

Site Name: Taylor Creek

Survey date: 2016-08-04

EO #: 7
EO ID: 2987
EO Rank old: AB
EO Rank new: AB

Number of sporelings: 321
Number of mature plants: 190
Number of immature plants: 377
Occupied acreage: 6.6

Field GPS points
Occupied acreage

200 Meters

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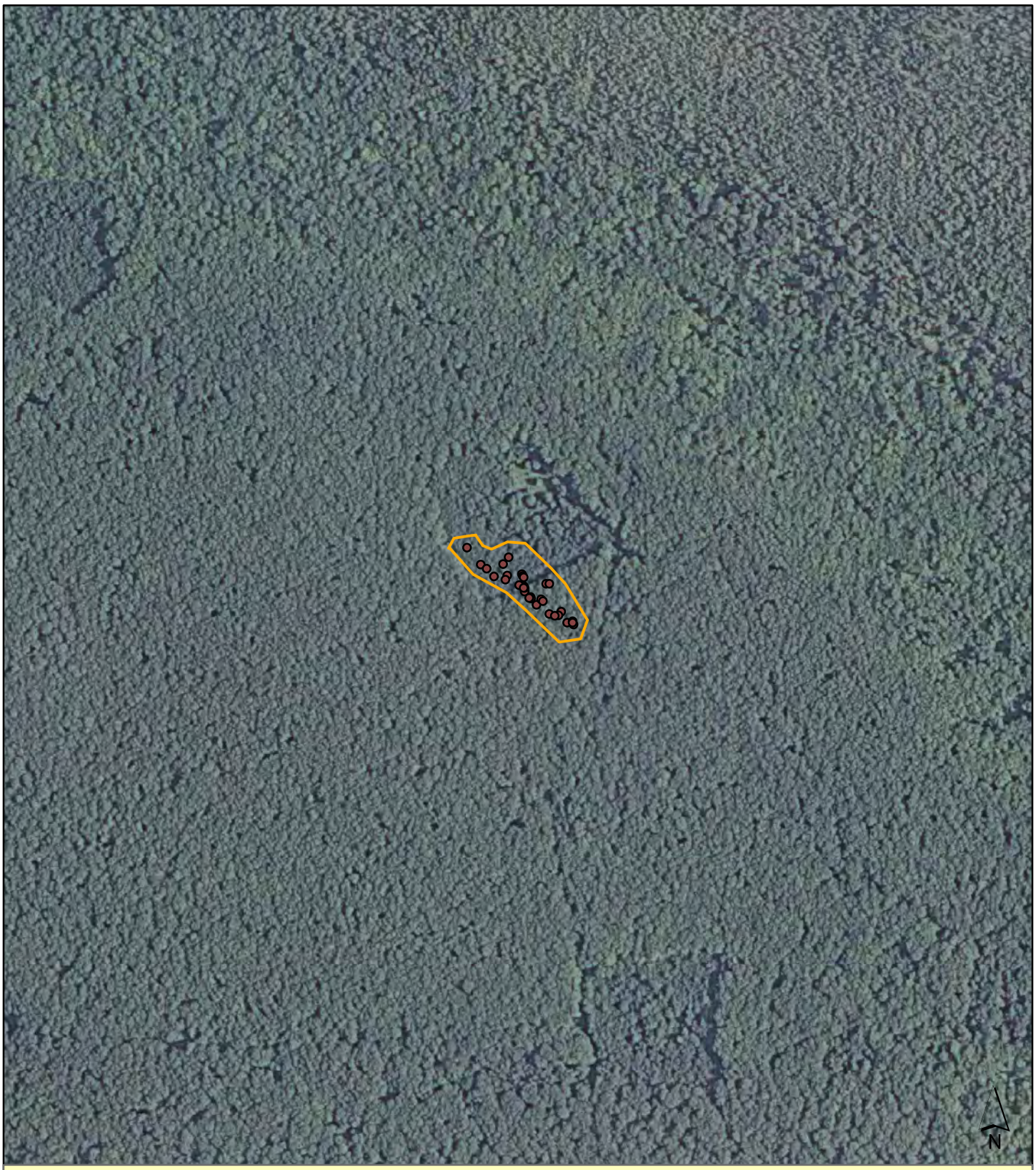
Michigan Natural Features Inventory



Site Name: Carp River North Branch *Survey date: 2016-08-05*

EO #:	8	**Number of sporelings:**	12
EO ID:	6448	**Number of mature plants:**	74
EO Rank old:	B	**Number of immature plants:**	43
EO Rank new:	B	**Occupied acreage:**	1.3

Field GPS points

Occupied acreage

200 Meters

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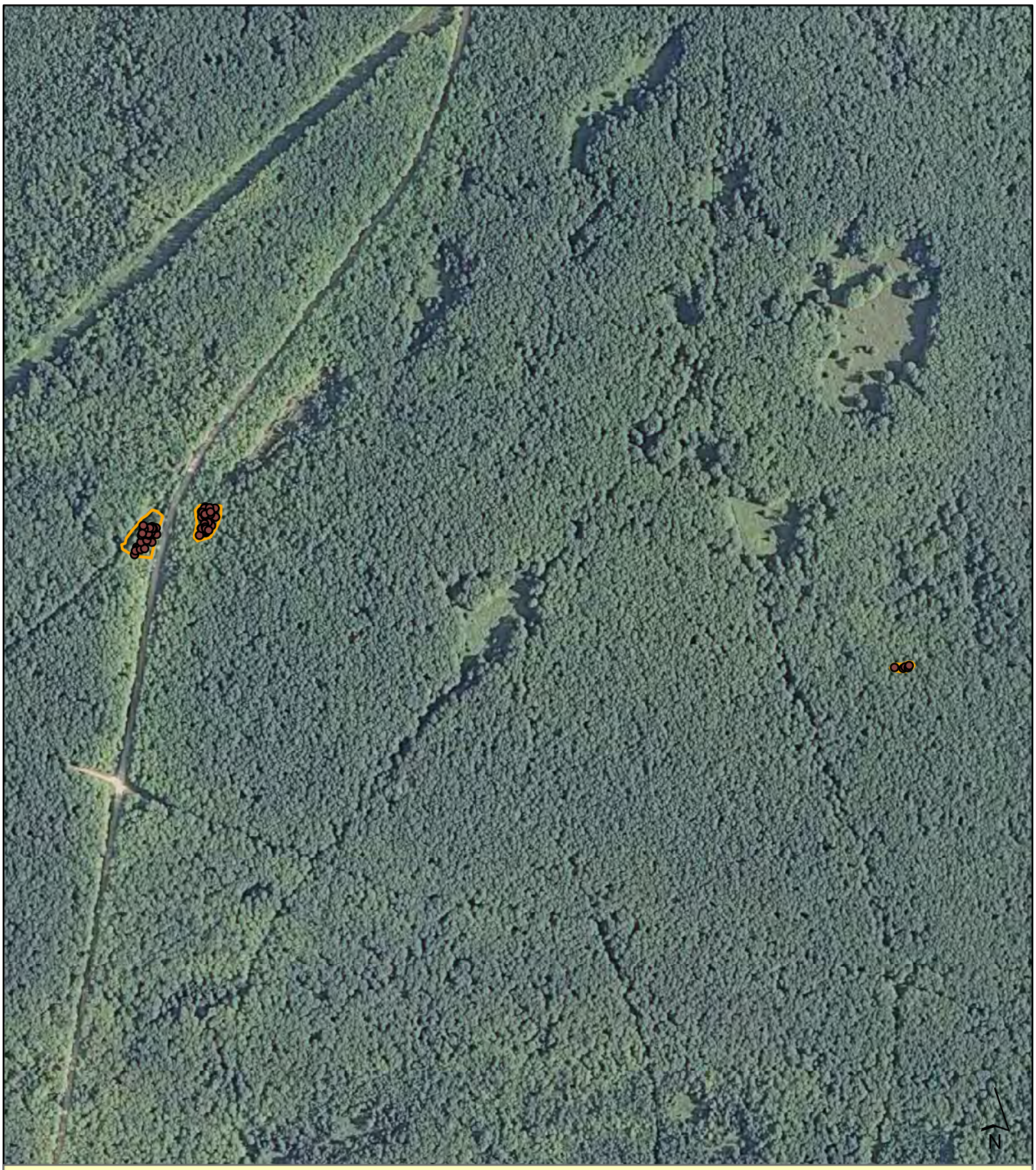
Michigan Natural Features Inventory



Site Name: East Lake Road *Survey date: 2016-08-04*

EO #:	9	**Number of sporelings:**	66
EO ID:	2695	**Number of mature plants:**	391
EO Rank old:	B	**Number of immature plants:**	146
EO Rank new:	B	**Occupied acreage:**	0.7

Field GPS points

Occupied acreage

260 Meters

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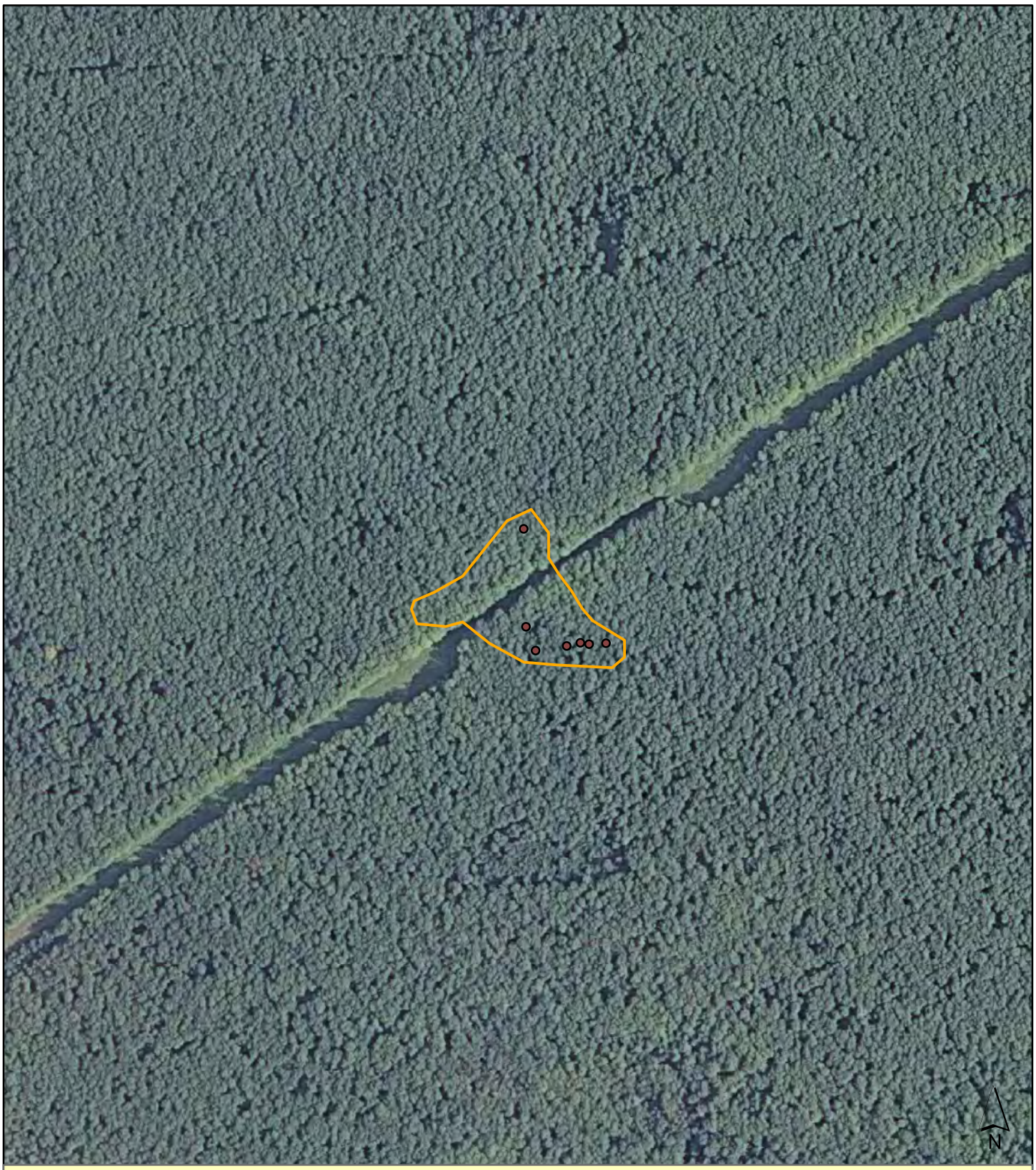
Michigan Natural Features Inventory



Site Name: Great Lakes Pipeline* *Survey date: 2016-08-04*

EO #:	10	**Number of sporelings:**	0
EO ID:	2696	**Number of mature plants:**	33
EO Rank old:	C	**Number of immature plants:**	13
EO Rank new:	CD	**Occupied acreage:**	3.4

Field GPS points

Occupied acreage

200 Meters

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Michigan Natural Features Inventory